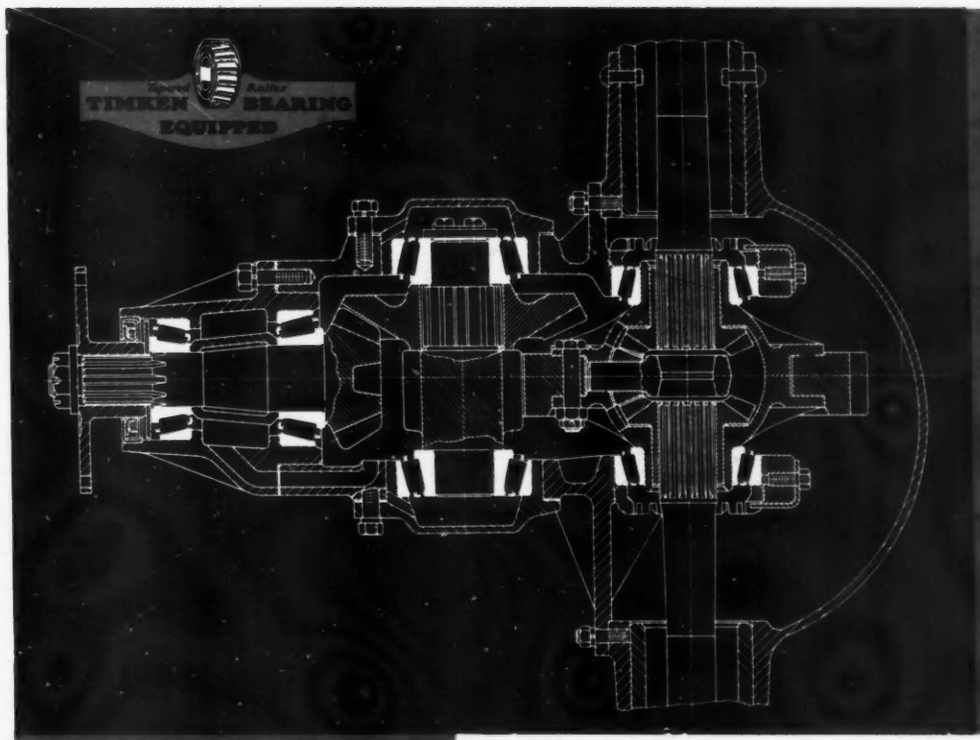
AUTOMOTIVE INDUSTRIES

LAND — AIR — WATER

DECEMBER 15, 1941



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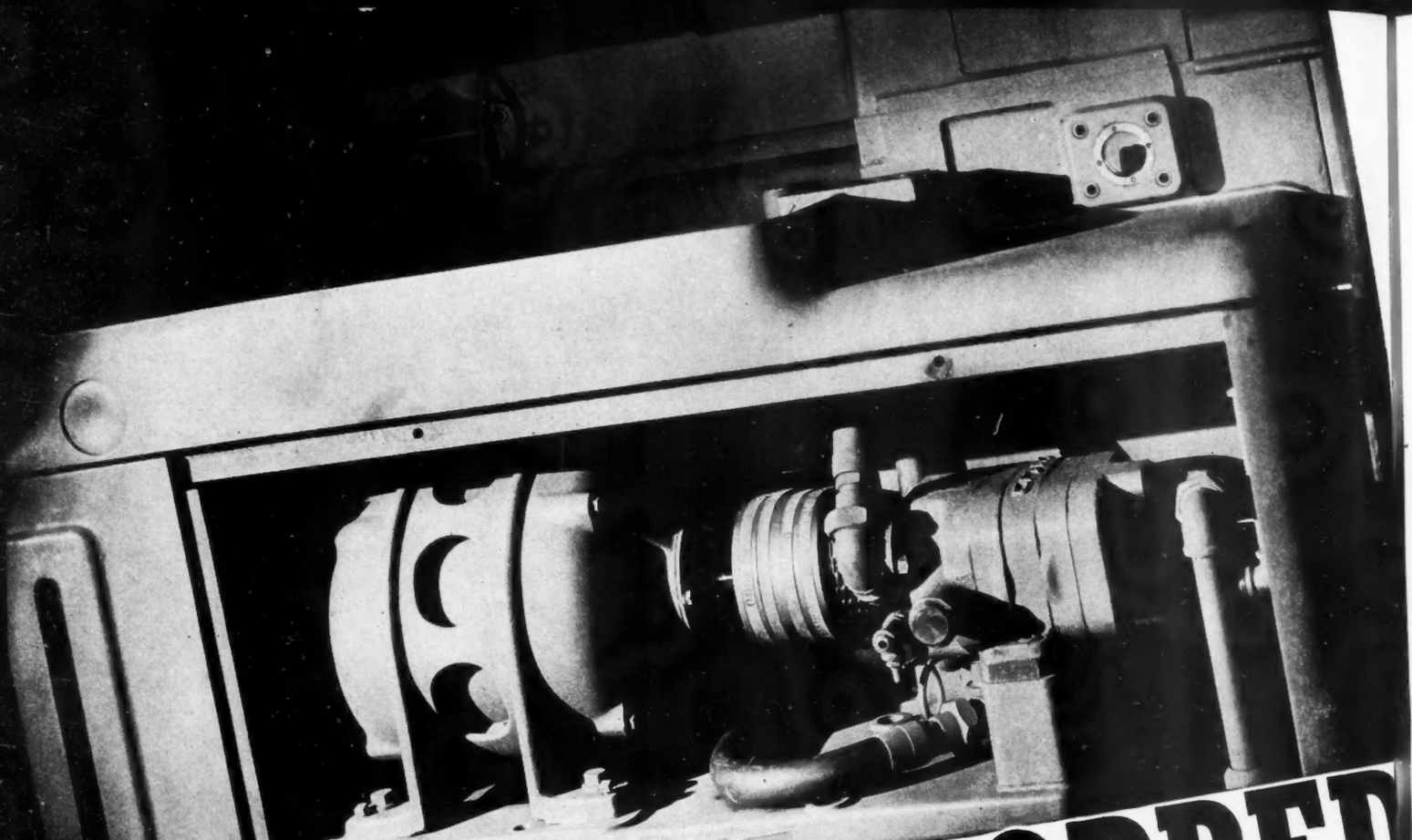

1200 JIGGLES PER MINUTE STOPPED IN THEIR TRACKS

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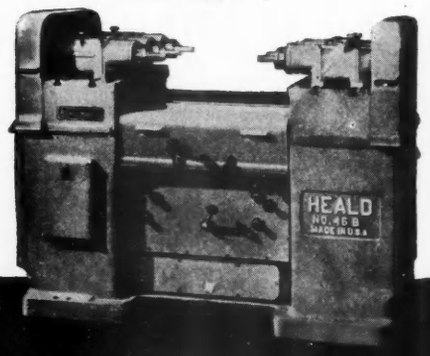
Outstanding characteristic of Heald Bore-Matics is the practically complete absence of vibration in the boring spindles. Machine elements that might cause undesirable spindle flutter are entirely isolated from the spindles, as explained at the left. Result is that on Heald Bore-Matics you can get extremely good accuracy and finish consistently, and maximum life from tools, too.

WHAT you see above is the main drive on a Heald Bore-Matic. Turn on the power and the whole unit gently vibrates at the rate of approximately 1200 times a minute. This is a lot of jiggling, but it stops right there. Heald engineers saw to that, for vibration must be entirely eliminated for best results in precision boring. First they quarantined this worst of vibration offenders — the drive motor, the clutch and brake drive and the hydraulic pump — by isolating these units low down at the rear of the base. Then they mounted the entire unit on vibration dampeners so that practically zero vibration escapes to the base. To make doubly sure they included multiple "V" belt drive from the motor, and flexible tubing between pump and hydraulic system to insure smooth transmission of power. And that is not all. Bore-Matics, too, have the clutch and brake unit also mounted on vibration dampeners . . . multiple "V" belt drive to boring heads . . . the base itself is extremely massive, rigid, to absorb any stray vibration. All these are reasons why Heald Bore-Matics are able to produce "tenth" precision consistently . . . and are A-1 reasons why Heald Bore-Matics should be seriously considered for every precision boring job.



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The AUTOMOBILE

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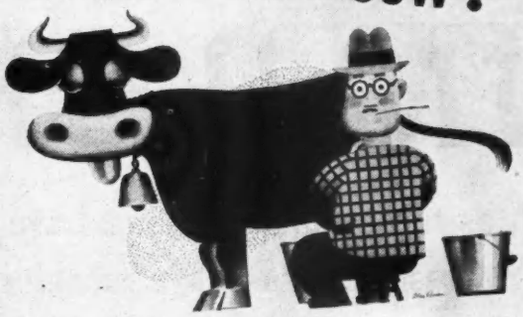

If you—a city dweller—should buy a cow you would get more milk—plus a lot of expense and bother. Chances are, you'll continue to patronize the milkman.

That applies to car building too. It takes about 42,000 parts to make an automobile. For quick, inexpensive and certain production of some of those parts, you, like the milk customers, prefer to let specialists lend a hand.

Borg and Beck specializes in clutches. Our single-minded devotion to bettering our one product has profited many a car builder.

Our talents are grooved to the design, production and prompt delivery of a clutch that you can install and then forget. Once in place, it actually lives the blameless and obscure clutch life that motorists have learned to expect.

That's why Borg and Beck sells millions of original equipment clutches a year. It's our way of helping you give your customers their money's worth.

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We Still Say What This Ad Said

TO PUT IT MILDLY, the world has seen plenty of changes since the above ad appeared back in '37.

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In 1937 we said that our clutch was the best clutch that skill, science and workmanship could produce. We say the same today of a vastly improved and thoroughly modern product . . . and we pledge our efforts to continue the Borg & Beck policy of improvement so that the ad above will still hold true at any time in the future.

Borg & Beck Division, Borg-Warner Corporation

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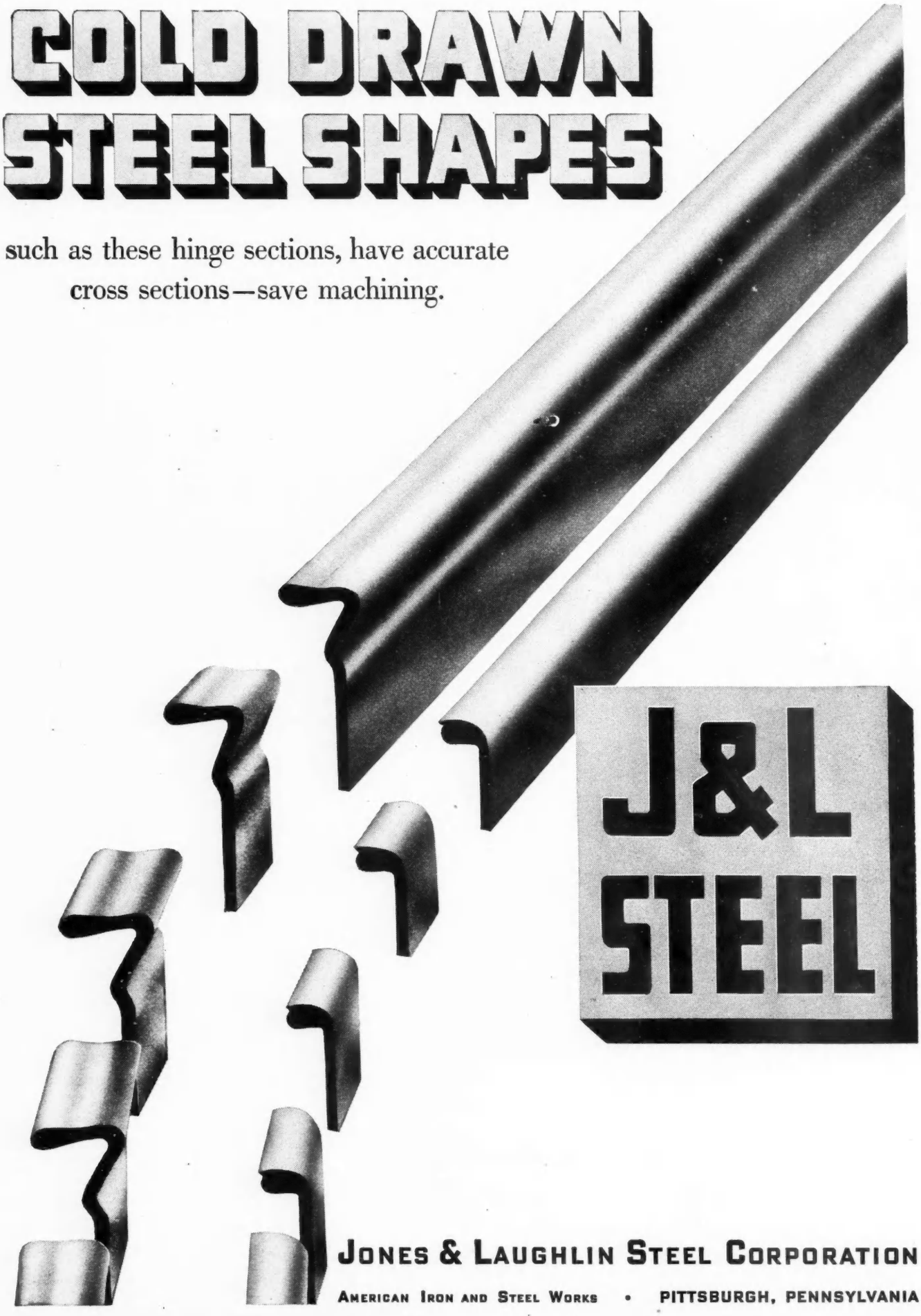
COLD DRAWN STEEL SHAPES

such as these hinge sections, have accurate cross sections—save machining.



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IN THIS ISSUE . . . .

AUTOMOTIVE INDUSTRIES

Reg. U. S. Pat. Off.

Volume 85 December 15, 1941 Number 12

Automotive Defense Plants Scattered in U. S.

An analysis of the distribution of the automobile industry's defense work shows the location of one or more motor defense plants in 17 states and 67 communities. On the west coast, three California plants are engaged in aircraft and military production. Army trucks are manufactured in Seattle. On the Atlantic coast, Connecticut has two automobile defense plants. Maryland makes motor trucks. New York, New Jersey, and Pennsylvania have motor plants in nearly a score of cities turning out tank parts, marine equipment, aircraft assemblies, etc. The South is represented by plants in Memphis, Atlanta, and Henderson, N. C. Michigan has defense plants in 11 cities; Ohio has nine; Indiana, seven; Wisconsin, five; and Illinois comes next with four. West of the industrial states, there are Missouri with two automobile defense cities and Colorado with one. Supply firms are scattered over nearly all of the 48 states.

Following normal practices in its automobile and truck business, the industry in 1941 farmed out a large part of the defense job to sub-contractors. An analysis of 104 random defense contracts showed 45 per cent of the dollar volume assigned to outside concerns.

A MESSAGE

TO YOU . . .

Defense Savings Bonds and Stamps give us all a way to take a direct part in building the defenses of our country—an American way to find the billions needed for National Defense.

The United States is today, as it has always been, the best investment in the world. This is an opportunity for each citizen to buy a share in America.

West Coast Airplane Industry Zooms into Big Production **18**

Just a few short months ago the airplane industry of the country was comparatively on a job-shop basis. With the entrance of the defense program into the picture there has been revolutionary changes in procedures and systems and management. This is the first of a series of articles that bring out these changes and show how the assembly lines have been built up and how the mass production methods have been accomplished in so short a time.

Airplane Assemblies in Perspective **24**

The old type of blueprint is a thing of the past in many of the airplane plants. A new type of drawing is being made that is better adapted to the less skilled types of workmen. It is a decided step forward. The story of its development and use makes interesting and informative reading.

Testing Propellers at Hamilton Laboratories **30**

Recent expansion of the testing laboratories of the Hamilton Standard Propellers Division of the United Aircraft Corp. enable it to do some far-reaching research in their field. This article, in picture and in text, shows how far reaching this branch of their work is being carried.

Powder Metallurgy **34**

This branch of the metallurgical field is given a going over by two authors that know their subject. One begins on page (34) and the other on the facing page (35). This really should be a "must read" for you as this subject is right up in the front ranks of production technique.

Transfer of Load Due to Braking in Tractor-Trailer Combinations **40**

Some few years ago P. M. Heldt wrote an exhaustive article on this same subject. So much change has been made in the design of tractor trailers that Mr. Heldt has brought the subject up to date with his usual exacting thoroughness.

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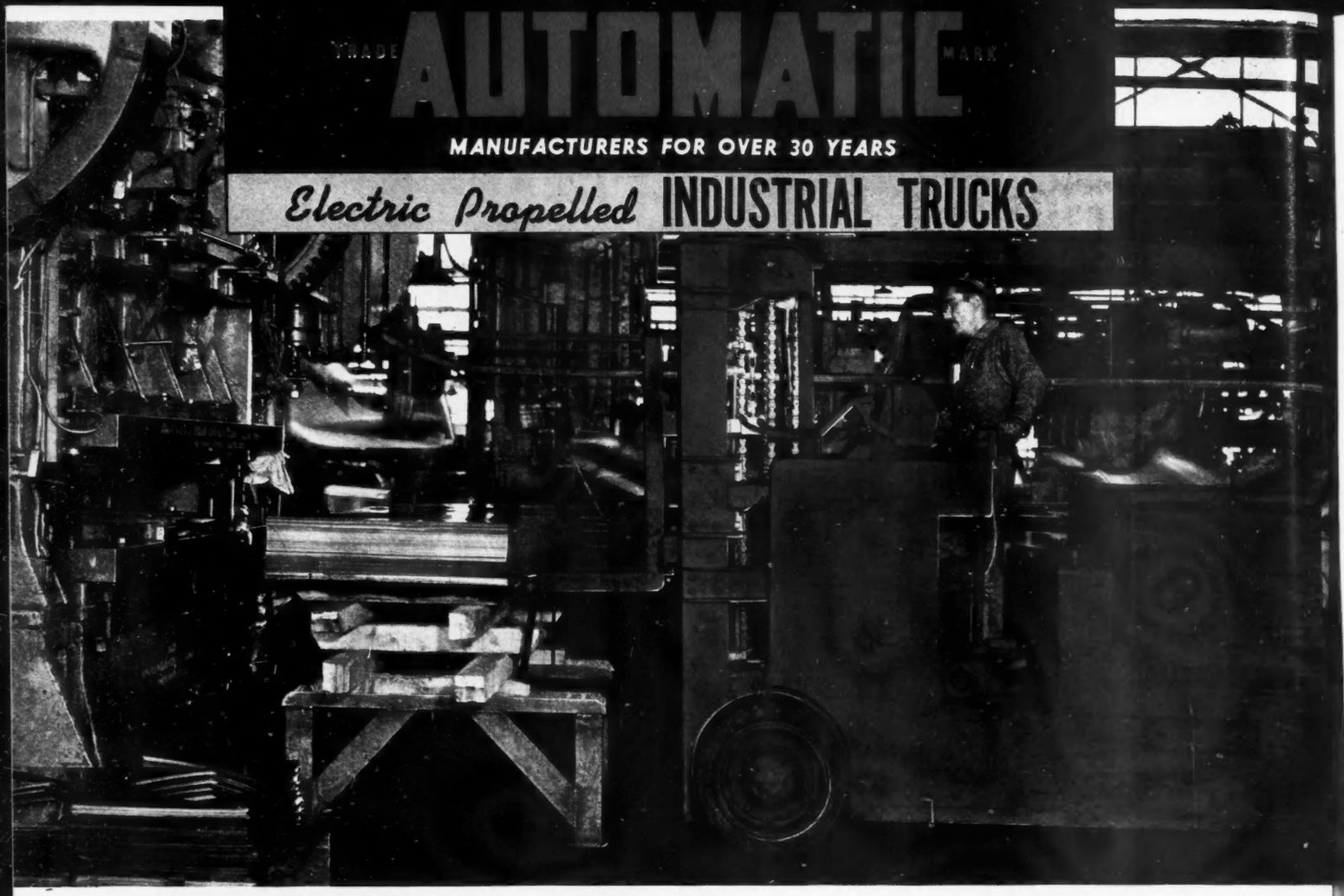
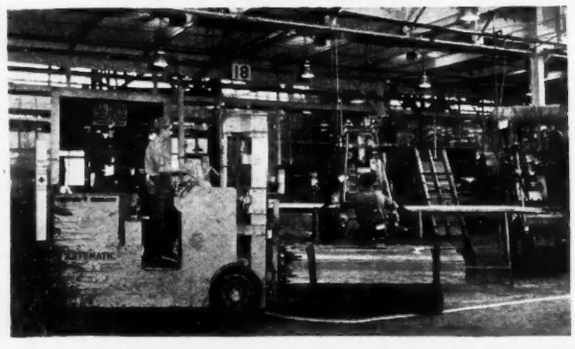
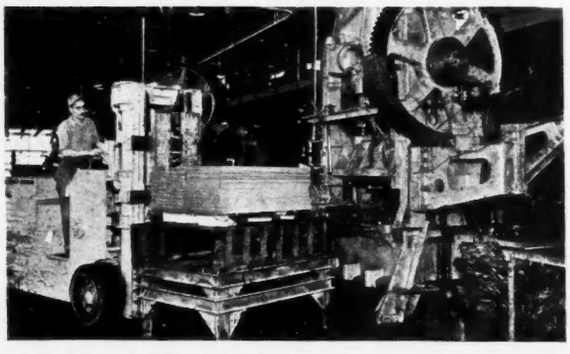
MANUFACTURERS FOR OVER 30 YEARS

Electric Propelled **INDUSTRIAL TRUCKS**







Heavy - duty "AUTOMATIC" Fork Trucks Service Production Machinery with Utmost Efficiency and Economy

The typical scene is in a large automotive plant where a large battery of die presses must be continually served on a 24-hour basis with metal blanks for making the variety of automotive body parts. Incoming bundles of steel plate weighing 10,000 lbs. each are transported to storage by "AUTOMATIC" Heavy-duty Telescopic Lift Fork Trucks. As the material is required at the die presses, the trucks remove same from storage and transport the individual bundles as shown to the various machines. Note how loads are deposited at the machines at heights convenient to operator.

This flexible method of handling metal material keeps the production machinery operating at highest peak, eliminates bottle necks, and provides a highly efficient stacking system resulting in controlled handling at lowest cost per unit. Write for full information without obligation.

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AUTOMOTIVE INDUSTRIES

Published on the 1st and 15th of the month

Vol. 85, No. 12
December 15, 1941

Industry Goes to War

A Pledge of All-Out Production By the Manufacturers of America

"INDUSTRY stands squarely behind the President and Congress.

"American lives have been lost in bombing; ships sunk; planes destroyed. These lives will be avenged through uninterrupted production on the factory front. The munitions of war can and will be replaced.

"Industry will build two battleships for every one that sinks. It will match every bomb with a dozen. It will blacken the skies with planes to replace the ones shot down.

"Industry's production to arm our fighting forces will be limited only by the human endurance of the men who man and manage its facilities.

"With every other patriotic element in the country, industry is on the march. It will produce, produce and produce to the end that victory shall be swift and sure."

The quotation above is from a telegram to the President of the United States from the President of the National Association of Manufacturers

West Coast

By JOSEPH GESCHELIN

THE eagles' eyrie—hatchery of wings for the Army and Navy, for Britain and China and Russia—that's the role of the airplane industry on the West Coast. Names already a by-word the world over originate from the small group of airplane builders nested in a circle about Los Angeles—with Consolidated to the south at San Diego, Boeing to the north.

Here are bred the famous Catalina patrol bombers—protectors of the North Atlantic convoy lanes; the four-engined Liberators for Britain; Hudson bombers, terrors of the skies over the invasion coast; Lockheed Lightning Interceptors; Vultee Vengeance fighters; high-ceilinged Consolidated B-24 four-engined bombers for the U. S. Army; Flying Fortresses; the Vega Ventura bomber now aborning said to be more deadly than the Hudson; Douglas and North American bombers.

It was the writer's privilege to see the eagles take form under factory roof, under huge tents in San Diego, under sunny California skies where most of the final assembly touches are made. It was truly inspiring to see with our own eyes a high tempo of production, certainly far beyond the gloomy estimates of self-appointed prophets of despair. For good and sufficient reasons the War Department has prohibited the publication of actual production figures. But it is no secret that the airplane industry has been producing at a great rate. Certainly it is no secret that this volume will be greatly exceeded in coming months.

Suppose we take a quick look at the record. According to figures released by the (California) State Employment Service, the airplane industry is currently giving employment to 138,000 workers; the 150,000 mark will be passed very shortly, with Consolidated, alone, taking on new workers at the rate of 1000 per week.

Although the airplane industry is being wisely decentralized with new establishments going into operation in Dallas, in Tulsa, in Kansas City, in Michigan, and in the South, the West Coast operations have been greatly expanded in recent months. Evidence of this is found in the huge Douglas plant recently dedicated at Long Beach, the new Plant 2 recently commissioned by Consolidated at San Diego, the new Vega plant at Burbank, and major expansion and realignment of the existing plants.

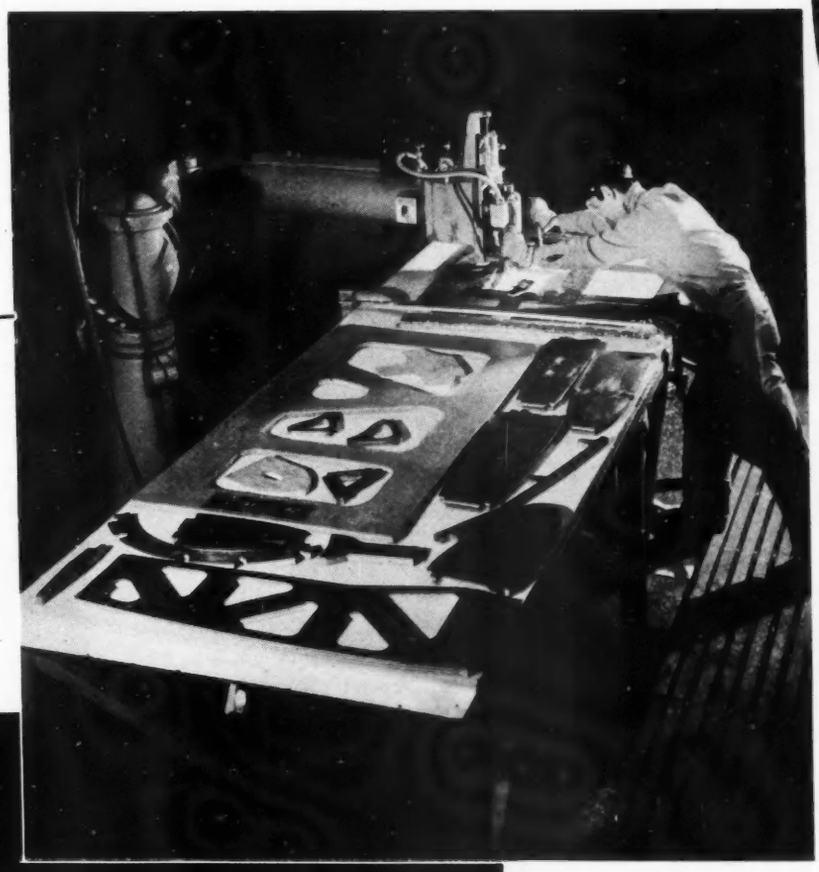
Doubtless much of the misconception as to the real state of affairs in the airplane industry arises from the fact that barely a year ago the activity was on a pre-war basis. Barely a year ago the airplane producers still were building on a small scale far from a mass-production basis.

But the picture has changed importantly. Make no mistake—the airplane industry is big mass-production

A large battery of Chambersburg Cecostamp, air-operated, hammers in the Douglas plant. These represent the modern successor to the familiar drop hammer. Chief feature is an accurately controlled stroke.

Airplane Industry
Zooms into Big Production

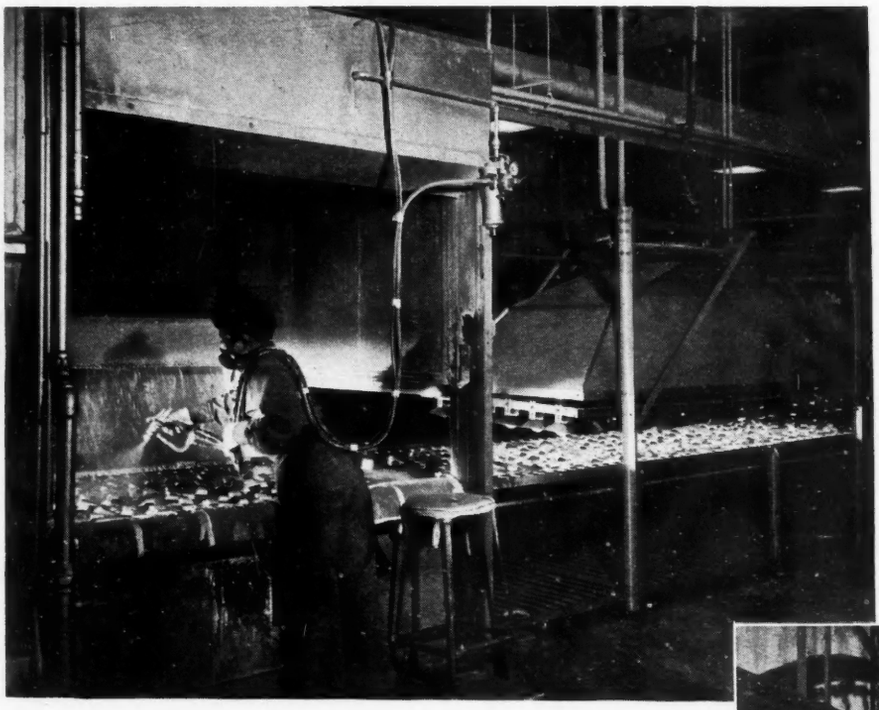
AVIATION INDUSTRIES

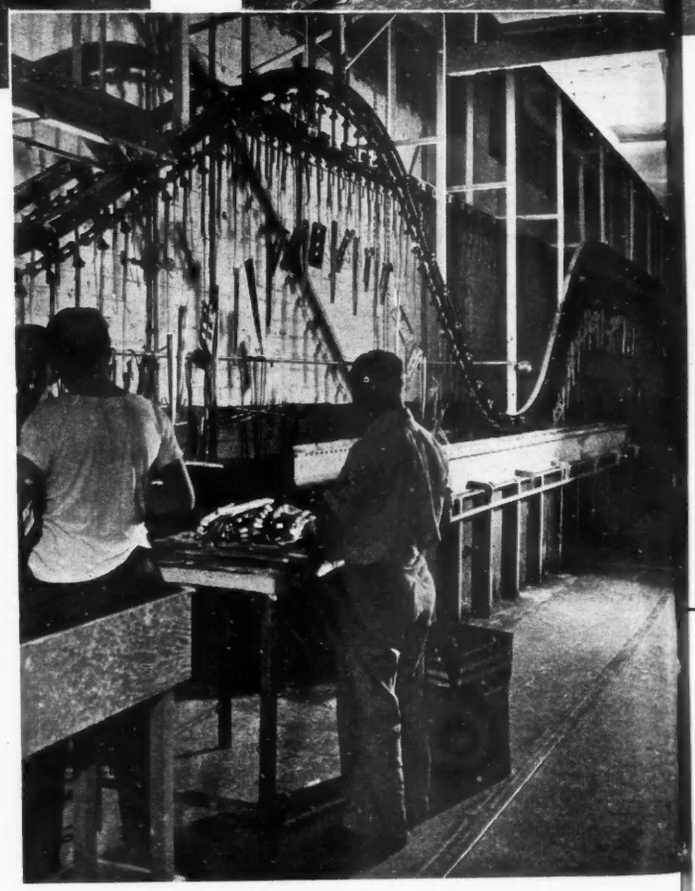


Familiar picture in an airplane plant. This is a vertical radial router in the Vultee plant routing out blanks for a Valiant basic trainer. It bears a striking resemblance to the cutting of layers of cloth to a pattern in an upholstery shop.

WITH the large part of the airplane industry located on the west coast, that section of the country becomes an important center of production in the present situation. A tour of the plants there has brought out many features new to the building of airplanes. This is the first of a series of articles that will tell all and show all. The next one is coming right along. Watch for it.

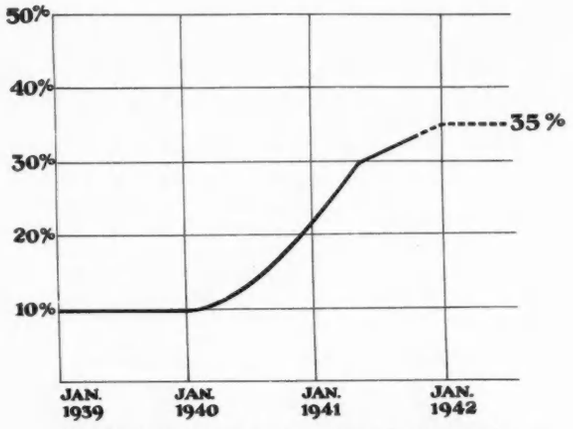
Out of doors under floodlights and in the glow of interior factory lights, the Lockheed night shift is busy putting the final touches on war birds for the U. S. Army. This view shows a crew pushing a Hudson bomber out of the plant hangar to the flying field for an early morning test hop.



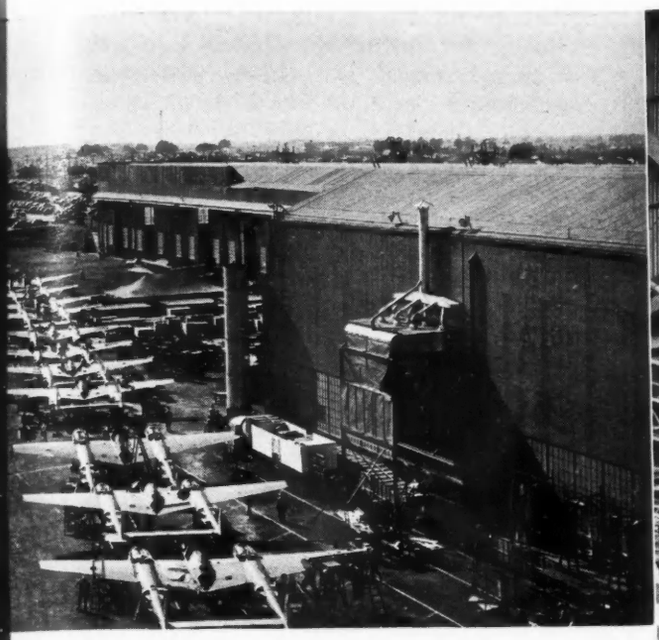


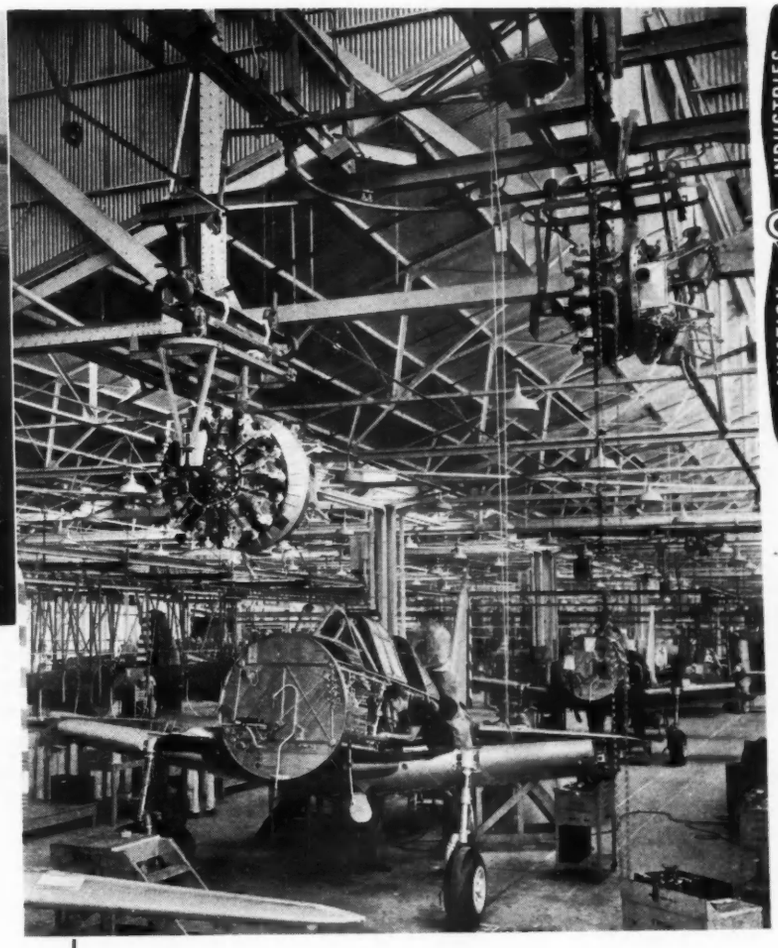
business today. To one who is a confirmed Detroiter with more than a bowing acquaintanceship with manufacturing methods of the automotive industry, the trip through these plants was an inspiration. Indeed, the present set-up would mark an inspiration for anyone who visits the West Coast. For here will be found the very latest types of familiar makes of metal cutting equipment in tool rooms and in machine shops, huge presses larger in physical size than most presses found in autobody plants albeit of less pressures, latest types of water-back spray booths larger than anything we have seen elsewhere—large enough to accommodate the largest bomber without cramping.

When it comes to materials handling there are industrial trucks, monorail conveyors, cranes and hoists, floor conveyors—all of the tricks known to the art. But particularly impressive are the mechanized assembly conveyors. Airplanes are being assembled on moving conveyor lines with overhead monorail drops for engines, for complete fuselage sections, for wing sections, etc. Perhaps the most imposing of these is the assembly building for the Consolidated B-24 bombers, among the largest of the four-engined ships made in this country. The assembly building houses a U-shaped conveyor line 1500 ft. in length. The bomber starts with the fuselage on one arm of the line, continues



North American steps up its sub-contracting activity to keep pace with the demand for more and more military airplanes.





(Top left) Another advanced paint line at Lockheed. This is a long table conveyor for painting and drying small parts. Work is loaded on the conveyor at the extreme left (out of this view); sprayed under the canopy at the left; dried while moving on the conveyor under the bank of powerful infrared baking lamps at the right.

(Top center) Outdoor assembly line for the British version of the Lockheed P-38 Lightning. About 30 per cent of the California airplane production floor space is out of doors.

(Top right) New mechanized floor assembly line at Vultee, showing the engine drop which is synchronized with the assembly conveyor. These basic trainers are moving forward into the background.

(Left) Example of modernity at Lockheed. Here is a monorail paint conveyor dipping its cargo of small parts in the tank at the right.

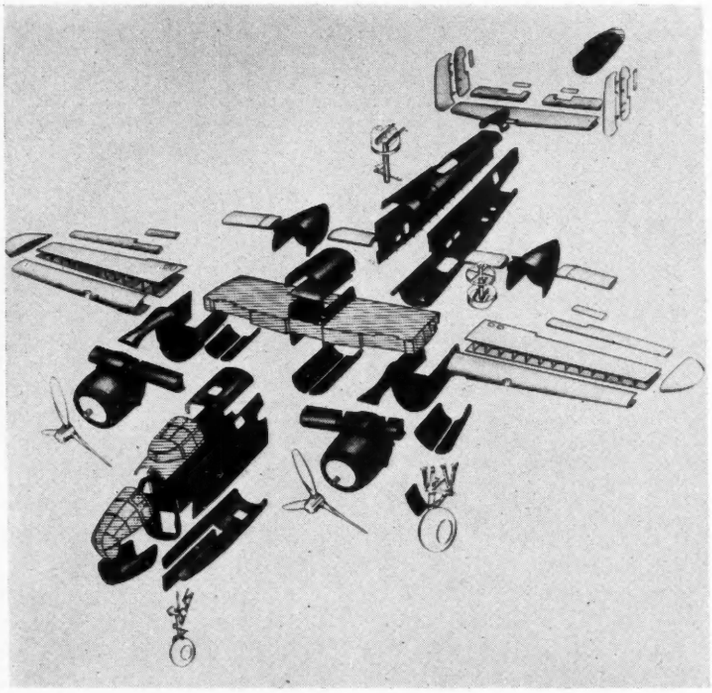
along 56 stations, winds up at the end of the other arm ready to take to the skies, after final touches, tune-up, and inspection.

Too, the airplane industry has developed new techniques which may prove to be of value to other industries. At Lockheed, a unique method for the rapid X-ray examination of castings on a really mass-production basis. At Douglas the introduction of the Guerin process of producing stampings with rubber dies. In others the development of fast and accurate methods of reproducing templates for stamped and formed parts by photo processes and by a new X-ray process.

Peering behind the scenes it is obvious that the overnight transition to mass production may be credited to the spirit of cooperation and unity between otherwise competing manufacturers in a time of national emergency. The fact is that many tricks and subtleties of fabrication of aircraft structures have been known and practiced in individual plants. These were their stock in trade, representing a margin of superiority when business was as usual. Today these techniques have been freely exchanged in the interest of the common good.

One way of spreading such vital information has been through the medium of sub-contracting. Not only in the sub-contracting of parts and main sections now being built by Fisher Body, by Murray and Briggs, by Ford and Hudson and Chrysler and others, but also by building other makes of complete airplanes. The industry now operates as a team—with the signals known and communicated to every member.

There has been some criticism in the past concerning design not suited to mass production methods. Doubtless there has been some justification—in the past—but it is quite evident that every airplane being built on the West Coast today has been analyzed and broken down into mass-production elements. Certainly the new models that are being introduced currently are designed for mass production. One of the interesting developments along this line is the technique of "Illustrated Production Break-Down" which was described by its originator—George Tharratt—at the S.A.E. National Aircraft Production Meeting. (See page 24 in this issue of AUTOMOTIVE INDUSTRIES.) The method is one of visualizing the break-down of the airplane structure into major and minor sections and assemblies, suitable for mass production, permitting fabrication and assembly at the highest possible pace. Not



Break-down chart of North American's B-25C medium bomber showing sub-contracted sections of the airplane. Dark and light-shaded areas indicate parts and assemblies furnished by the Fisher Body Division.

only does this method set up the production procedure but it provides the workers with a perspective drawing which enables them to visualize the final form of the part on which they are working.

The author of the paper has introduced this technique in several of the larger plants on the West Coast, his latest connection having been with Douglas. Huge Douglas bombers are built according to this procedure, one of the most impressive sights at the Santa Monica plant being the assembly of fuselage sections on a mechanized assembly conveyor. The fuselage is constructed in two halves, cut longitudinally down the center, the mating halves being made up in separate fixtures running parallel down the assembly line. An interesting development at Douglas—which by the way is being adopted in other plants, is the use of massive framing fixtures made up of welded tubular members. Some idea of the size of the tubing may be gained from the fact that much of the material is salvaged pipe-line. These new framing jigs are so massive and so rigid that there is no possibility of mis-alignment or lack of dimensional accuracy of the finished assemblies.

The West Coast plants are proficient at welding having had plenty of experience with the welding of aluminum and tubular structures. This was the proving ground for the remarkable Sciaky resistance welders. And today the largest batteries of these controlled cycle welders are found on the Coast. More recently these have been supplemented with specialized welders built by Federal, Acme, Taylor-Winfield, and others. Every trick of the welder's trade is employed —the oxy-acetylene torch, electric arc, spot welders, butt welders, seam welders.

Before the airplane producers were able to take advantage of mass-production press shop methods, every plant relied upon the use of the drop hammer. During the past year, drop hammer dies have been made of Kirksite, a special high zinc content alloy. We had heard of this activity but did not realize that this meant that each plant owned and operated its own zinc foundry with from one to three large melting furnaces, served by pattern shops, model shops, and provisions for making plaster forms for casting the dies. And a yearly consumption of thousands of tons of zinc metal, most of it reclaimed over and over again.

However, with the mounting tide of airplane construction, we find the entry of huge drawing presses bearing names familiar in the automotive field—Clearing, Hamilton, Birdsboro, Bliss, Hydraulic Press Mfg. Co., and others. The older drop hammers are giving way to the modern hydraulic press, although all of the available equipment will continue to be employed in the interest of getting the job done in a hurry. Several press shops boast large batteries of the Chambersburg Cecostamp presses which constitute the modern version of a sensitive but powerful successor to the drop hammer.

Another important newcomer in the field of metal stretching is the Erco "stretching press." Douglas and several others have installed this equipment recently. Instead of forming large skin panels in big presses with bulky dies, the aluminum sheet is stretched over a wood form. The ends of sheet are clamped in hydraulic hold-downs on fixed tables flanking the center station of the machine, while bent loosely over the form. Then the center section is slowly inched upward to the end of a pre-determined stroke, deforming the sheet into the desired contour. Fast and simple, it represents a major saving in time and expense.

Among the familiar items of modern metal working machinery found in these plants—both in machine shops and tool rooms—are Cincinnati grinders, Cincinnati Centerless Grinders, Cincinnati Milling Ma-

chines, Kearney & Trecker milling machines, Conomatics, Cleveland automatics, Brown & Sharpe screw machines, Foster and Gisholt turret lathes, Keller machines, drill presses, Do-All machines, Monarch lathes, Niagara press brakes, Cincinnati shears, and many other items of equipment to be mentioned later.

It was the writer's observation that the extent of metal cutting activity was in direct relation to the amount of parts sub-contracting now in effect. Some of the smaller plants have more machine shop facilities than do the larger ones, primarily because the larger producers have parts made outside to a greater extent.

With the passing of time the airplane producers and their sub-contractors will be able to introduce still further refinements in production methods, in special techniques for conserving precious time. One recent development along this line is the widening use of the du Pont explosive rivet for blind fastenings. This has proved popular and valuable as a means of reducing the time for joining inaccessible sections, not only speeding up the assembly but materially reducing the cost and assuring a safer blind fastening.

Now for a thumbnail sketch of the principal airplane producers of Southern California.

Douglas Aircraft Co., with headquarters in Santa Monica, has an employment of 33,000 at this writing, counting the full employment at Santa Monica and El Segundo, and a skeleton force at the newly dedicated Long Beach plant. With the Long Beach and Tulsa plants in full swing, Douglas will employ 75,000 workers, 7000 of these at Long Beach.

Vultee Aircraft at Vultee Field, about 18 miles out of Los Angeles, home of the mighty Vengeance fighter, employs 7600 workers, operates one of the most highly

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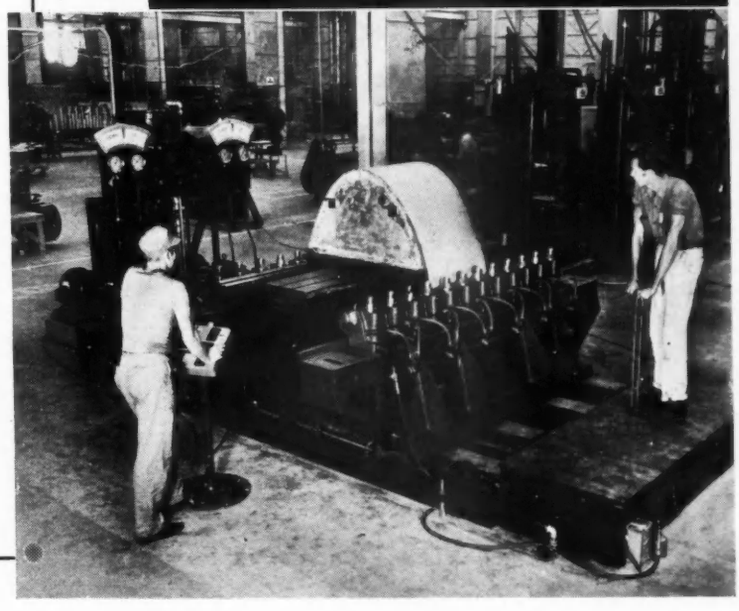


(Above) Building under California skies. B-25 bombers receive final assembly touches and inspection out in the open on North American's flight ramp. In the background are Harvard and AT-6A advanced trainers ready for fly-away delivery.

(Top right) Example of one of the large specialized presses, this Birdsboro has a rotary bed loaded with small stampings for Vultee basic trainers and Vanguard pursuits.

(Lower Left) Good evidence of Northrup's sub-contracting activity. Here is a big department devoted to the fabrication of Boeing B-17E Flying Fortress engine nacelles.

(Lower right) This is the newly installed Erco metal stretching machine at Douglas. Large skin sections are formed rapidly, using wood forms.

AVIATION INDUSTRIES

Airplane Assemblies

By GEORGE THARRATT*

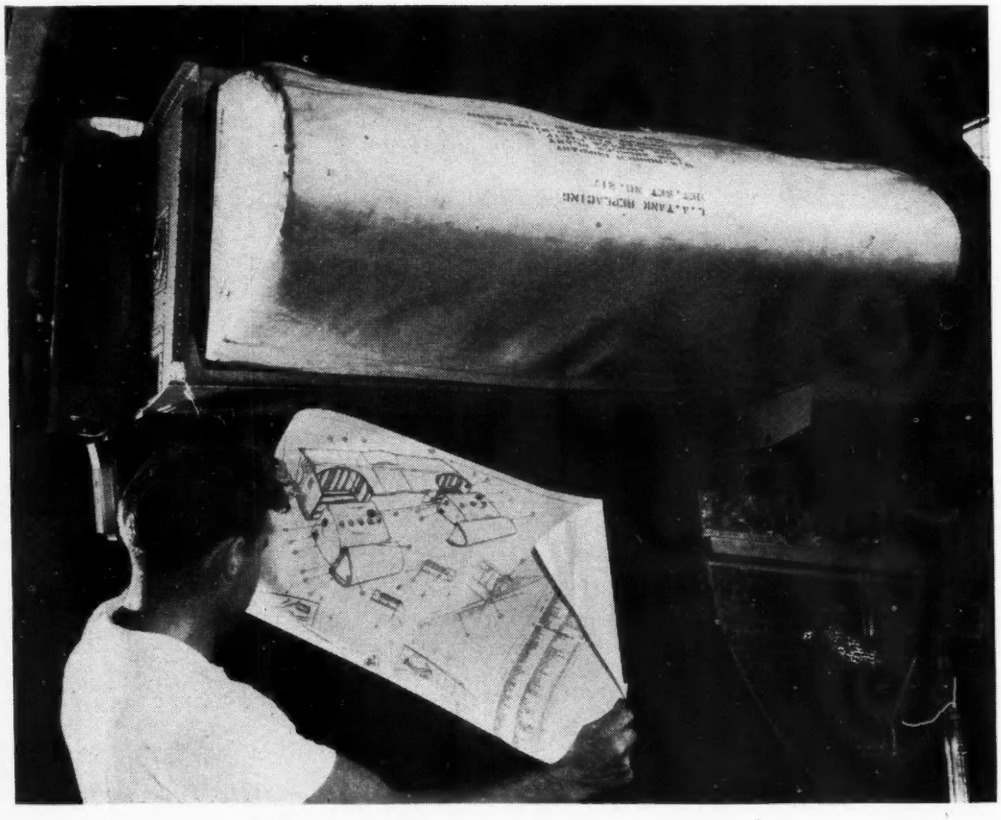
IN SEEKING new methods to speed production, the aircraft industry has found in the breakdown illustration system an effective means for accomplishing that purpose. Not only does it facilitate assembly operations, but also the training and absorption of thousands of new employes into this rapidly expanding industry.

Douglas Aircraft Co. began developing its system four years ago and late in 1939 a complete picturization of the proposed manufacturing breakdown and its progressive detailed fabrication, plus a position breakdown plan, on a mechanically moving assembly line was for the first time included in a military airplane bid. In anticipation of the present rush of orders and consequent expansion problems, Douglas organized the Production Illustration Department. Since then the system has been improved to eliminate the use of blue prints on the final assembly lines. It is incorporated in the basic layout of the new Douglas Long Beach plant.

* Abstract of paper read at recent S.A.E. National Aircraft Production Meeting in Los Angeles, Calif. When the paper was prepared, Mr. Tharratt was Co-Ordinating Supervisor of Production Illustration, Douglas Aircraft Co. Since then he has become associated with Adel Precision Products Corp., Burbank, Calif., as Chief Engineer.

On the staff of the Production Illustration Department are engineer-artists known as production illustrators, who translate complex designs and masses of data into simple, comprehensive drawings of the cutaway, three-dimensional type to show where the subassemblies and parts are to be attached in accordance with a numerical operation sequence. Thus, the possibility of mistakes is eliminated, thereby saving the time of valuable supervisors and leadmen who would otherwise find it necessary to explain the job to each workman many times over. It also affords some guarantee that the job will be done in the best and quickest manner, since the procedures have been originated by experienced mechanics, each of whom are specialists in their line.

The first duty assigned to that department was to study and break down into manufacturing production units the DB-7 type twin-engined attack bombers. At that time the fuselage was being fabricated as a complete unit and difficulty was being experienced with installations on the final assembly line due to the very restricted working space in such a small fuselage. Perspective sketches were made showing suggested remedies for this condition, and after several con-



Studying the installation of fuel tanks

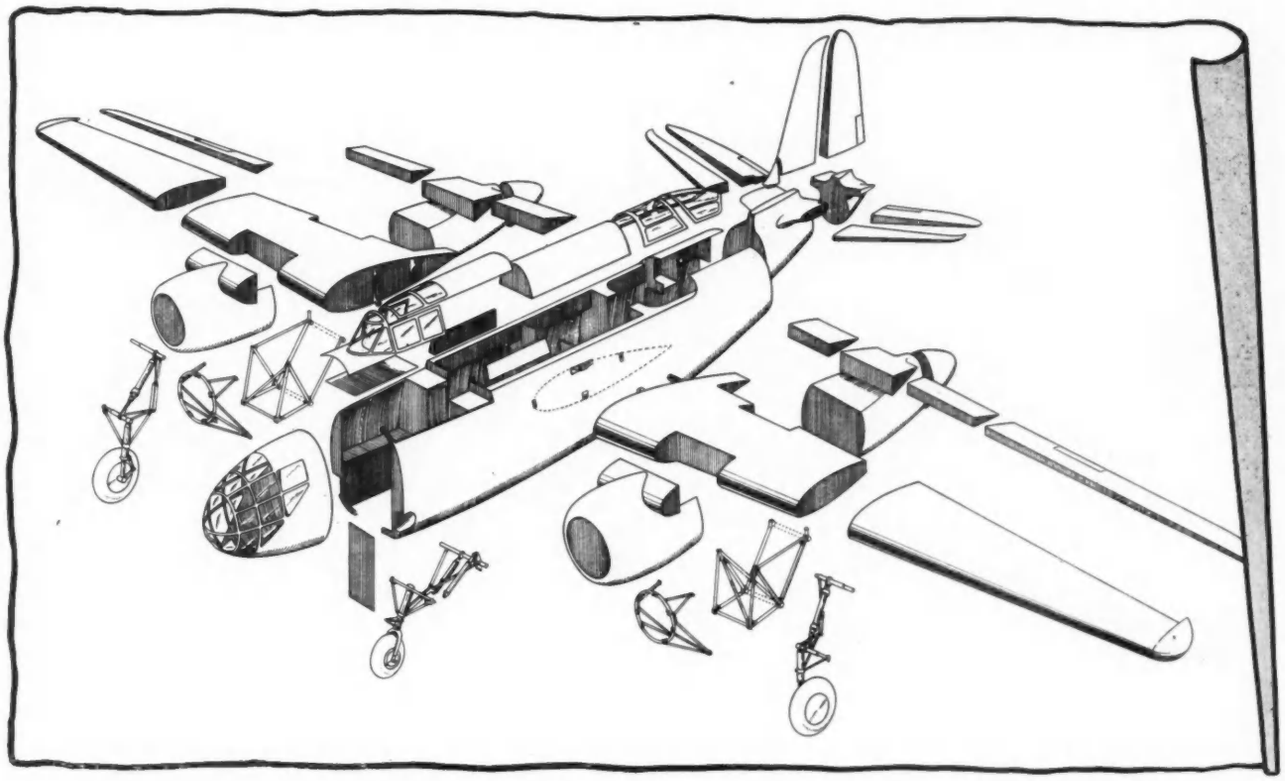


Fig. 1 — Typical production breakdown diagram of a Douglas light bomber

in Perspective

Breakdown Illustration System at Douglas Aircraft Co. Contributes Substantially to Accelerating Production

ferences with the engineering and tool design groups, it was decided that the fuselage be split vertically on the center line and fabricated as right and left halves as shown in Fig. 1. This allowed more men to work on fuselage fabrication with greater freedom of movement. The same advantage also applied to the assembly line where the two halves received their respective installations. It developed that nearly 80 per cent of the internal equipment and functional installations could be installed before the two halves of the fuselage reached their joining positions on the assembly line. The fuselage halves on the assembly line were divided into working zones for the purpose of illustrating in detail the work to be done in these zones (Fig. 2) at every position on the assembly line.

From this experimental beginning a definite procedure was established for all models in all manufacturing divisions which is best illustrated in the graphical form shown in Fig. 3. The work-loading graph between the preliminary design stage and actual freezing of production techniques on the final assembly line has two distinct curves. One is for engineering which starts at 100 per cent and reaches "0" at the middle of shop development. The other is for manufacturing which starts at "0," and reaches 100 per cent at the same point, returning to "0" at the point of freezing on the final assembly line. The work of the Production Illustration Department covers the four distinct, but overlapping phases.

Phase 1.—The basic design for an airplane evolves from a specification submitted for competition by the Army or Navy and brought into being on paper by the Preliminary Design Department. At this stage production illustrators study the new design and break it down into manufacturing units after consultation with the Engineering Production Design Group and Tool Design Department. Ultimately they issue a production breakdown diagram (Fig. 1). This diagram is accepted as the basic breakdown to be used by the Engineering Division for structural design and functional installation design, and by the Tool Design Department in like manner for the design of major

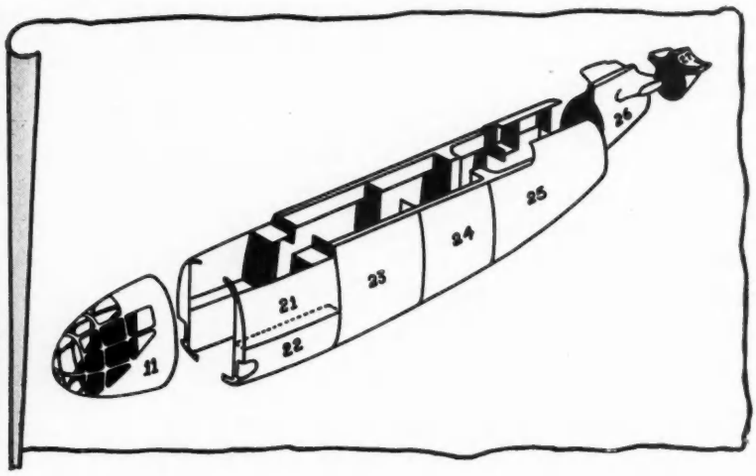


Fig. 2—Fueselage zone chart

jigs, tools, and fixtures. The Factory Planning and Shop Fabricating and Assembly Line Development groups refer to it constantly in performing their functions. So also, the Lofting, Production Planning, Estimating and other departments find it to be of value in planning their work.

Phase 2.—The next step is the structural unit breakdown illustration, an example of which is shown in Fig. 4. Each structural unit assembly as shown on the production breakdown diagram (Fig. 1) is illustrated separately in true perspective and further broken down into manufacturing sub-assemblies. This breakdown is made during the preliminary design stage in consultation with the Engineering Production Design Group and the Tooling Department. The sketches are used by the Design Group as a guide for structural and detail design and by the Tooling Department for the scheming of sub-assembly jigs, tools, and fixtures. On completion of the engineering design structural unit illustrations are brought up to date and issued to all departments concerned.

The Materiel Division is responsible for the distribution of copies to any sub-contractors concerned. If, for example, the inner wing is manufactured outside the Douglas plant, the sub-contractor receives a structural unit breakdown illustration of the complete unit, plus separate illustrations of each functional installation, such as Engine Installation, Fuel and Oil Lines, Hydraulic, Electrical or Landing Gear.

The next step is in the making of functional installation illustrations concurrently with the preparation of engineering layouts. Accurate perspective drawings are made of all functional installations such as Flight Controls, Hydraulic System, Fuel and Oil Systems with their Controls. These drawings are used by the

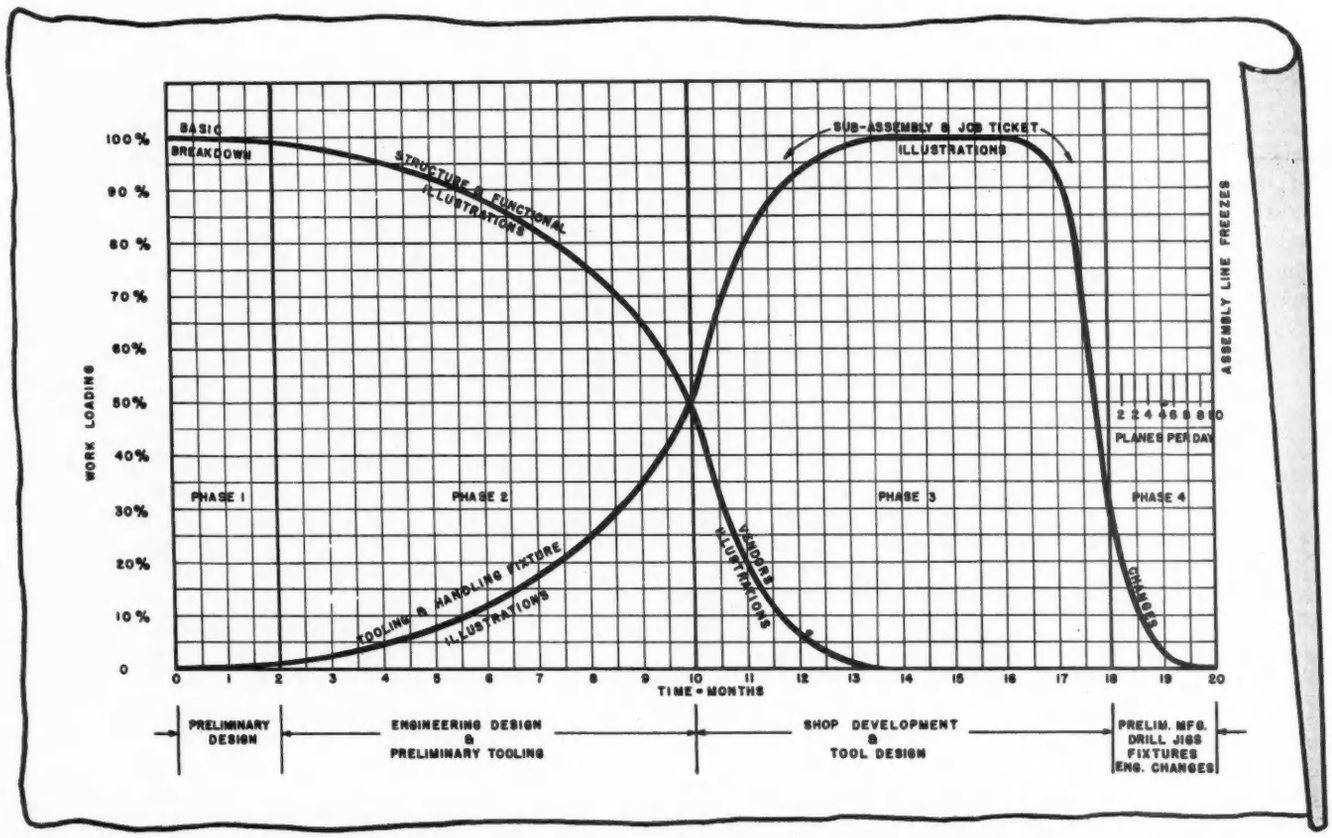


Fig. 3—Work loading chart for engineering and manufacturing stages of Douglas bombers

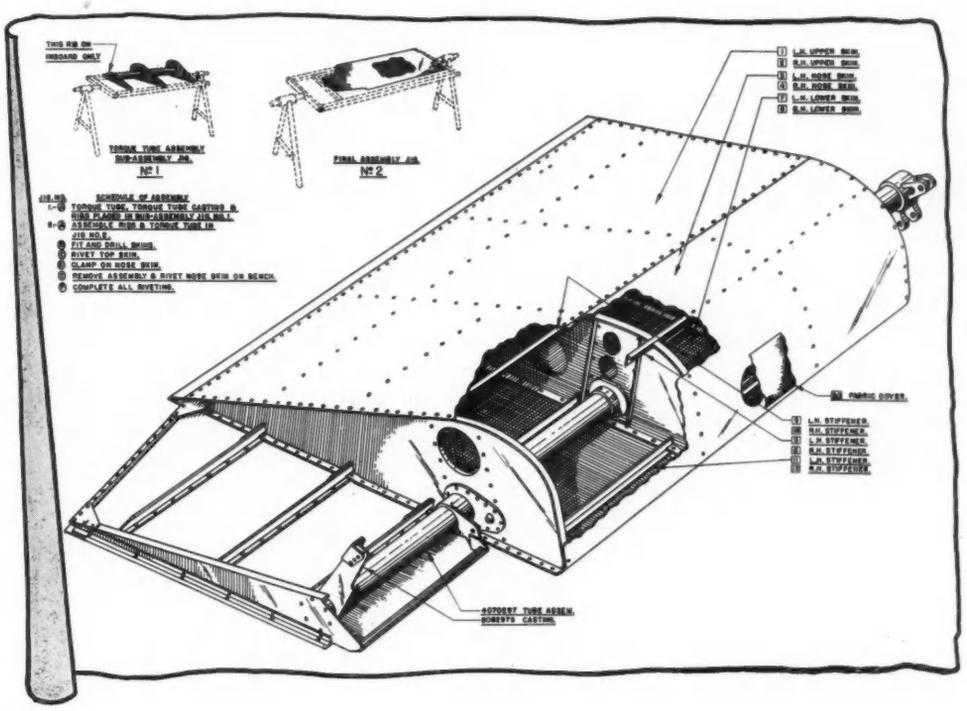


Fig. 4—Typical structural unit breakdown illustration. Shown is an inboard wing flap of a Douglas light bomber

various engineering groups, by the Handbooks Department for inclusion in their service and instruction manuals, the Materiel Division for ordering purposes, the shop coordinating supervisors and their development men for studying the assembly line breakdown and generally throughout the factory for instructional purposes. Instructors in the Educational Department find these diagrams especially effective in the training of new company employes.

Phase 3.—This phase starts when enough engineering and major tooling information is available for a profitable study of fabricating and assembly operations to be made by the Manufacturing Development Group which estimates, from information given on delivery dates, the number of positions for the fabrication, sub-assembly and final assembly, together with floor space and storage space necessary to complete the job in a given time. Here, then, is where the production breakdown diagram, the complete set of structural unit breakdown and the functional installation illustrations are again extensively used to obtain a coordinated picture of the engineering blue prints.

To help the development men estimate the allocation of work necessary in each zone for each position, key sheets are made. These key sheets are skeleton perspective sketches of the fabricated structure in each zone, showing frames, angles, and attaching brackets for receiving the several installations. Black and white prints covering each position on the line are issued to the development men, who mark in the work to be done on their particular installation, indicating the approximate location of each part or sub-assembly and giving a list of tools necessary to do the job with the numerical sequence of the operations necessary. Similarly, a list of the nuts, bolts, screws and clips

Fig. 5—Perspective drawing with tool and operation lists on illustrated job ticket for final installation of nose wheel

JOB TICKET No. 1812-22 **MODEL A-20A**

TOOL REQUIREMENTS

½" Drive Ratchet	1 Large Screwdriver
½" Drive 1" Socket	1 Pair Diagonals
⅜" Drive ½" Socket	1 Pair Pliers
⅜" Drive Ratchet	1 Brass Bar 10" Long
1 12-oz. Ball Peen Hammer	

Operation No. PROCEDURE

1. Install Strut Assembly
   Apply a thin coat of parker thread lube to pin (A) before installing. Install as shown in Detail "A"

(A) 1098970	Pin	1 Req.	(B) Ac386-4-13	Taper Pin	2 Req.
1098967	Washer	2 Req.	An380-2-2	Cotter	2 Req.
An380-4-4	Cotter	2 Req.	An975-5	Washer	2 Req.
An320-10	Nut	2 Req.	An320-5	Nut	2 Req.

2. Install Mechanism Assembly
   Use Same Procedure As In Step No. 1

(C) 1090965	Pin	2 Req.

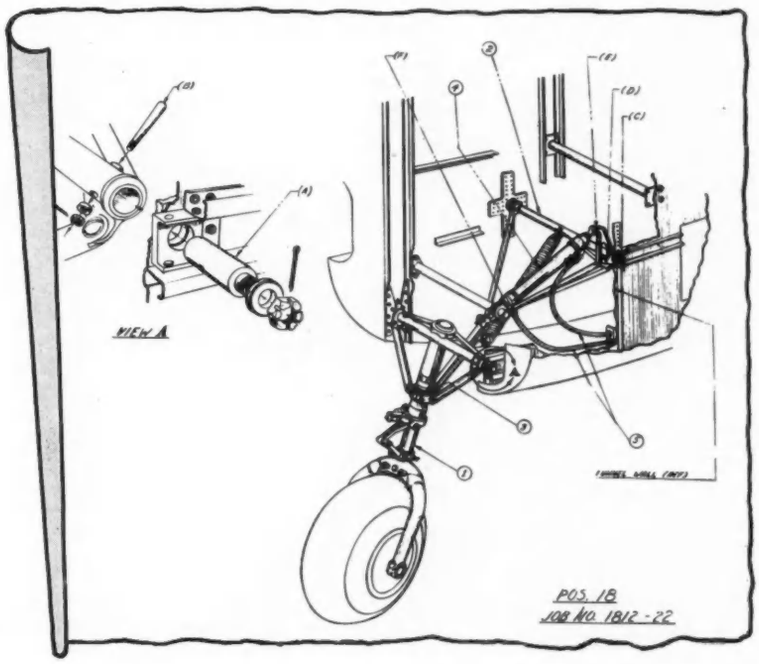
3. Connect Mechanism Assembly to Strut Assembly

An29-36	Bolt	1 Req.	An960-916	Washer	1 Req.
8-1026614B9-108	Spacer	1 Req.	An380-4-4	Cotter	1 Req.
An320-9	Nut	1 Req.			

4. Install Cylinder Assembly

(E) An6-15	Bolt	1 Req.
8105960-8-375-624-749	Spacer	1 Req.
An310-6	Nut	1 Req.
An960-616	Washer	1 Req.
An300-3-3	Cotter	1 Req.
(F) An6-14	Bolt	1 Req.
8105960-8-375-624-749	Spacer	1 Req.
An310-6	Nut	1 Req.
An960-616	Washer	1 Req.
An380-3-3	Cotter	1 Req.

5. Connect Hose 84896490-21 & -18 to Cylinder
6. Tighten and Safety All Nuts and Bolts



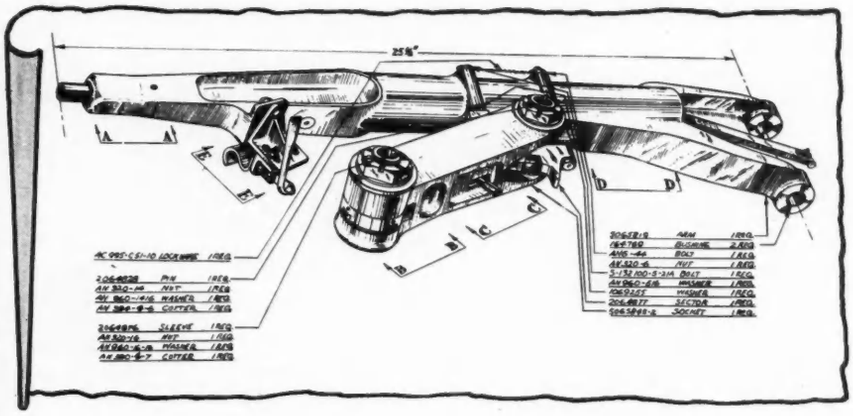


Fig. 6—Sub-assembly sketch for mounting lower flex gun. Four sectional views also are included on the drawing

required to attach each part is included with other data.

When all the key sheets are marked they are used as a means of: (1) checking against overcrowding any one installation zone; (2) checking the location of various installations to prevent interference with other parts; aiding the routing of parts or sub-assemblies to the production line by simplifying the determinative installation zone; (4) quickly locating installations or assemblies on the production line, or any changes.

After all key sheets are assembled and coordinated, job tickets are issued by the Planning Department with a job number. This job number first gives the position number on the line, -18, its installation code number -12 (means hydraulic assembly units), and its zone number, -22 (indicated on Fig. 2 as the zone under the pilots' floor). This gives a job number, 1812-22, as shown in Fig. 5. The Production Illustration Department then takes each of these job tickets in their order of priority and from their accompanying marked-up key sheets makes the illustrated job tickets, which for a complete series are based on an elapsed time schedule for the entire assembly line. Fig. 5 shows the perspective drawing on an illustrated job ticket for the final installation of the nose wheel, being a two-hour elapsed time job ticket. On the right-hand side the ticket has a list of tools necessary for the job, followed by a listing of each operation in numerical sequence with a corresponding number on the sketch. Operation No. 1, for example, is sub-divided into two sub-operations (A) and (B), giving an enlarged view of the parts and their pictorial sequence of assembly.

Sub-Assembly sketches (Fig. 6) are made concurrently with the illustrated job tickets. These drawings are made after consultation with the Production Planning Department and are used as an illustrated guide

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Allison Route Sheets in Graphic Form

WHEN Cadillac began manufacturing Allison aircraft engine parts at its Detroit plant, simplification of procedure was needed beyond the route sheets. Tasks were new to all employes and in addition the production of aircraft engine parts imposed greater difficulties.

To meet this need, a system was devised for transferring each manufacturing step on the route sheets to separate information sketches. A staff of General Motors Tech students was recruited to prepare these sketches and supplementary data for machinists.

While route sheets still exist, the system permits short circuiting them. Job-setters are supplied with cards listing the tools needed for new set-ups. Machine set-up time is reduced appreciably and much of the previous lag in putting a part revision order in effect also is eliminated.

In the accompanying photographs, the draftsman is making an information sketch showing the profile of an Allison drive gear and a machinist checks the hub of a gear blank with the specification on his information sketch.

Airbriefs

By HENRY LOWE BROWNBACK

Steel to Steel Bearings

There has been a great deal of talk about hardened steel-against-steel bearings in many parts of aircraft and this has been further brought to public notice as one of the mass production cars adopted it in rocker arm bearings.

My first experience with steel-to-steel bearings was in an old 1909 Franklin car and they were used in the rocker arms of all Anzani engines, in the Brownback C400 and the 3-cylinder Jacobs aircraft engines in the rocker arms.

Most of the men who convert stock outboard engines into 7000 r.p.m. racing jobs fit the piston pins directly into the heads of the rods instead of using the usual bushing. One French controllable pitch propeller having heavily loaded high speed gears which had given bearing trouble with all types of bushings finally succeeded with hardened gears running on nitrided pins. Properly loaded, properly lubricated bearings made of properly treated and selected steels have many applications.

Plastic Surfaces

Speaking of the chemist, not long ago a roll of plastic impregnated fabric was turned into wing flap surfaces by being wrapped around a special sectional core and then placed in a heated mold and cured for a short while. When it emerged and the core sections were removed, the flap was all ready, polished surfaces, integral bracing, etc. We are going to see more and more of this cooperative "chemist-engineer" engineering.

Balloons

In spite of the fact that we hear little of balloons, they are playing a major role in this war and it is interesting to note that our Government has invested almost $2 million in enlarging the helium plant at Cliffside, Tex., to give it 66,000,000 cu. ft. per year additional capacity.

Berrylium

And speaking of light metals, you may be flying on the principal constituent of the precious emerald before long. A few days ago I was shown a sheet of metal resembling platinum in sheen and color, but it was far lighter than aluminum. The scientist who gave it to me asked me to bend it. As the sheet was about 1/16 in. thick I thought it would be easy until I tried. It was as stiff as steel. Beryllium airplanes may soon be an article of commerce and will be lighter and faster than anything we now know.

The Vicious Circle

In World War and post war aviation we were faced with the vicious circle of power-weight and then someone built a relatively streamlined low-wing monoplane and all former conceptions of airplane design became obsolete. Just at present we are in another vicious circle between armor protection and armament. Maybe some genius will come along with something revolutionary and solve that one.

Bombing

This question of high altitude bombing is most interesting and one must take off his hat to the designers of our modern bombsights. If you were going to bomb New York's Central Park at the altitudes being used today you would actually let go your bombs somewhere over South Brooklyn. This may give a vague idea of the problems involved especially when the falling bomb may pass through air currents going in several directions on its way down.

Bellybumpers

Remember the sleds bearing this inelegant name? Modern military aviators are getting used to this position as most bombadiers work lying prone and now it is rumored that one of our newest fighters will be piloted from a prone position as the pilot is less affected in power dives than when sitting and the visibility in a totally streamlined machine is better.

Carburetion

Designers of all kinds of machinery are plagued by a circle of problems which often become a cycle. A certain engine has bearing trouble and this is fixed and power is stepped up and the spark plugs go bad. Then this is eliminated and power is stepped up again and valves give trouble and when the valves stay put and another power increase is made, the bearings again make themselves heard. Today the high-power engine problem seems to be carburetion and it is no secret that much midnight oil is being burned in an effort to develop a new system of carburetion, something many experts feel to be necessary if rapid progress in aircraft engine design is to continue especially with the trend toward high altitude fighting and bombing.

Japanese Engines

We have heard much of the ability of the Japanese to copy and I have seen some pretty good copies of well-known American products in their European exhibits, even to trade marks, but they haven't been able to copy anybody's high powered aircraft engines. The highest power they have produced themselves is less than 1000 hp.

Magnesium

Another increase of importance is that of 60,000,000 lb. per year of magnesium in plants at Lake Charles, La., and Austin, Tex. The greatly increased capacity of the nation to manufacture light metals and plastics as compared to that of the pre-war period may affect our post-war life considerably.

Pushers

Many persons who have studied aviation and can easily see the many advantages of the pusher type airplane over that fitted with a tractor propeller for military work wonder why practically nothing is being done with this arrangement. The answer lies in the problem of getting the crew out with parachutes in an emergency.

Metallized Engine Finishes

Air cooled engines have always worked under the handicap of black enamelled cylinders and heads. The metal had to be protected and baked black enamel stood up better than anything else even though it was far from ideal as a heat radiator. The latest technique is metallizing with sprayed-on molten aluminum in special machines.

Messerschmitt 109F

This high altitude fighter can do 380 m.p.h. and has a service ceiling of 40,000 ft. Its Mauser cannon fires 900 shells a minute, really a formidable weapon. Looking back to the World War Fokker shows how far aviation has progressed. We Americans have no cause for shame. In those days we did not produce a single series of pursuit planes and today we have the Curtiss, Bell, Brewster, and many others of equal value. Some of our relatively inexpensive sport planes with comfortable cabins will outfly and outclimb the best of the World War fighters.

Substitutes

Substitutes might be better called "replacements" and substitutes for the usual materials may lower the actual cost of building small airplanes. In one light plane nearly all of the hard-to-get materials have been eliminated and the increase in weight is just 20 pounds and the plane is cheaper to build.

AVIATION INDUSTRIES

Testing Propellers at

By NIRAN BATES POPE

EXPERIMENTAL science, which advanced the Hamilton Hydromatic propeller to its present wide acceptance, is being directed today in further development work, mapping out what might be called the stratosphere of aeronautic propulsion. Tomorrow, some day next year, or maybe three or four years hence, increased demands for distance, altitude, lift and size of planes will have moved far ahead of present-day limits. When that day arrives the Hamilton Standard Propellers Division of United Aircraft Corp. proposes to have the answers ready for many new questions that will arise.

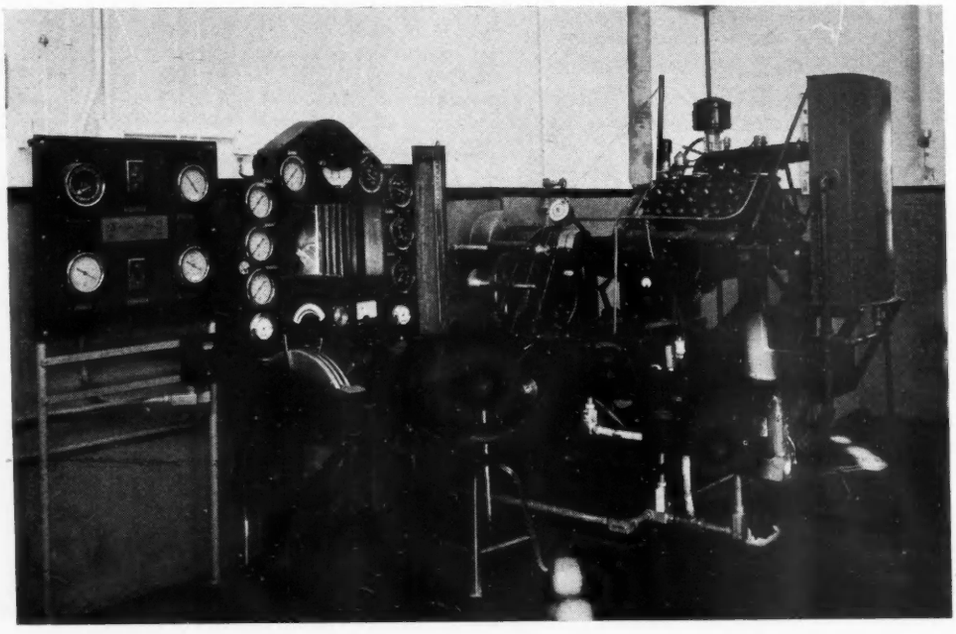
Recent expansion of the Hamilton laboratory facilities at East Hartford, Conn., is noteworthy because it comes at a time when the manufacturing plant is working on an all-out basis in three shifts, turning out the standard product at a rate never before attained with propellers of the automatic feathering type. Design may be frozen for the sake of manufacturing economy, but to be progressive, the art must be held in the fluid state.

How to determine precisely the force and deflection at any point on a propeller blade when it is rotating rapidly about its supported end, and also spiraling into space at several hundred miles an hour—experimental science at Hamilton Standard has worked out the answer by a highly original method. For this purpose it has evolved a remarkably sensitive strain gage, scarcely larger than a piece of court-plaster on a cut finger, which it somewhat resembles. Attached to the surface to be tested, fine wires lead away from it to an electric metering circuit, through slip rings if the part is being tested while in motion. Even a microscopic extension or compression of the surface to which the "plaster" is applied produces a minute change in the latter's electrical resistance, which is absolutely related to the force producing the change. This appliance is used in measuring deflections of propeller blades in operation and is subject to verification by standard laboratory methods for testing materials.

In studying the vibration of airplane propellers, the strain gage not only indicates, through accurate interpretive instruments, the characteristics of such disturbances, but can be used to determine the point of possible rupture. It has made possible the forecasting of the life expectancy of the blades, under normal working conditions. Propeller failures, fortunately always rare, have become almost negligible since this technique was developed.

Alternating stresses produced by vibration are closely measured in terms of force and frequency by detecting the changes in resistance of the little carbon strips, glued to the parts under test. Tiny alternations resulting in a small electromotive force applied to the gage are stepped up by means of radio amplification actuating an oscillograph and tracing a wave curve on sensitive paper. Proportionate scaling of the "height of the waves" measures the deflecting force at the point of stress, while the wave frequency is the frequency of vibration.

Vibration in an airplane propeller may be the re-



Control room for the cold test rig

sultant of many variable forces, producing unbalance. Before it is mounted on the plant the propeller is placed in absolute static balance. Yet in service, under certain rare and critical conditions, vibration may appear. When that circumstance arises the propeller manufacturer must be able to prove that the disturbance is not caused by unequal distribution of the masses within the structure itself (dynamic unbalance), and that it is not caused by bending or fluttering of the blades, or from unequal thrusts against the air caused in some other way by the whirling mass, in either or all of which may lie the cause of "aerodynamic unbalance."

These examples illustrate the uses of perceptive and metering methods which were not invented until the need for exact information about airplane propeller behavior called them into existence. Most of the special equipment at the Hamilton Standard propeller laboratory, like the strain gage and its application in studies of vibration, is of original conception, based on original test apparatus and either constructed in the laboratory or built by specialists to this organization's specifications.

Recognition of the effectiveness of the methods is evident in the fact that Army, Navy and Civil Aeronautics Authority have required the Hamilton Standard vibration test as a qualification for every new propeller application. This covers the application of a new type propeller to any existing plane, or a standard propeller to any plane of new design.

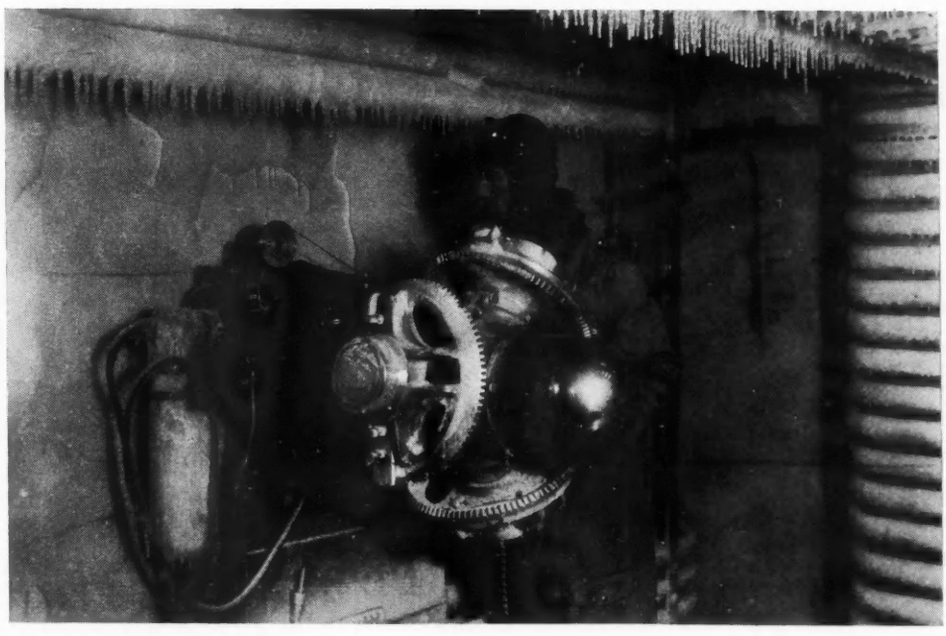
A great deal of fundamental research underlies the work. Several of the basic studies, as they progressed during the past four or five years, have been recorded in the proceedings of various engineering societies.*

While continuing with basic development, propeller research has also moved into a new field of variable influences under service conditions with studies of the effects of temperature changes on aerodynamic performance and the behavior of materials. Hence the use of the "cold room" and the "whirl rig," whereby the operation of propellers and accessories may be studied over a range of 200 deg. Fahr., all the way from 50 deg. below to 150 deg. above. This is considerably more than the range encountered by a plane coming in at high altitude from a northern winter climate for a landing in the tropics.

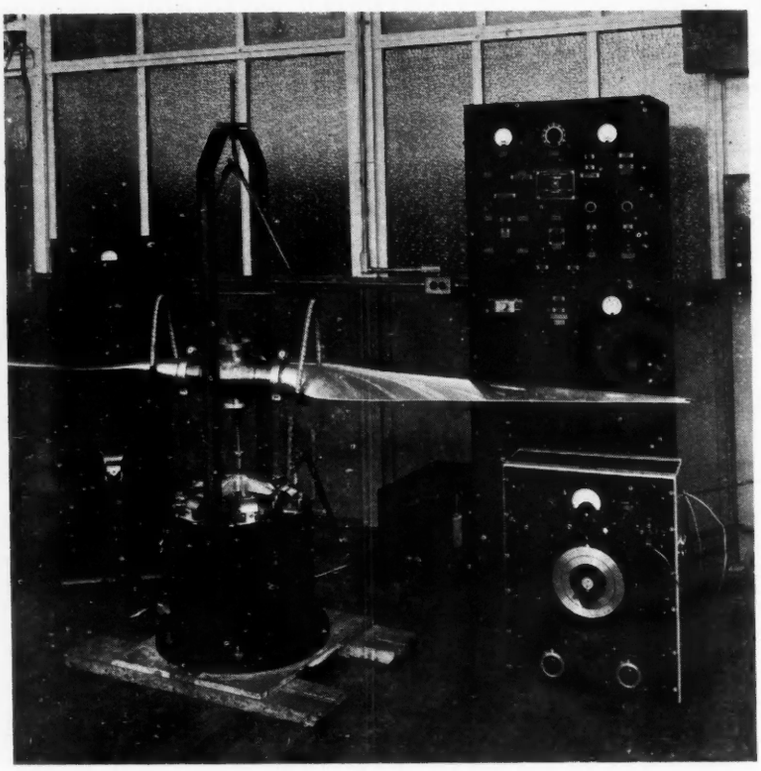
Not only must the effect of temperature variation on aerodynamic performance be studied, but a number of very stiff mechanical problems are involved. The automatic feathering propeller incorporates in the hub assembly an exceedingly sensitive governor mechanism. A single Hamilton Hydromatic propeller, of the type used on multi-engined transports, may have as many as 1100 parts, which must be built to exceedingly close tolerances. The pitch changing mechanism must not only compensate for differences in

*See: "The Vibration Problem in Aircraft Propeller Designing," by F. W. Caldwell, *S. A. E. Jour.*, Aug., 1937; "Vibration Stress Measurements in Strong Centrifugal Fields," by Charles M. Kearns and Ralph M. Guerke, *Jour. of Applied Mechanics*, Dec., 1937; "Vibration Characteristics of Aircraft Engine-Propeller Systems," *S. A. E. Jour.*, Dec., 1939; "Balancing of Aircraft Propellers," by Murray C. Beebe, Jr., and R. K. Mueller, *Aero Digest* (Series of four articles, Feb., Mar., April, May, 1940).

Hamilton Laboratories



In this cold room, with temperatures as low as 50 deg. Fahr. below zero, Hamilton Standards are tested to determine their suitability for arctic and substratospheric operation.



Apparatus for determining high frequency vibration characteristics and fatigue life of Hamilton propellers

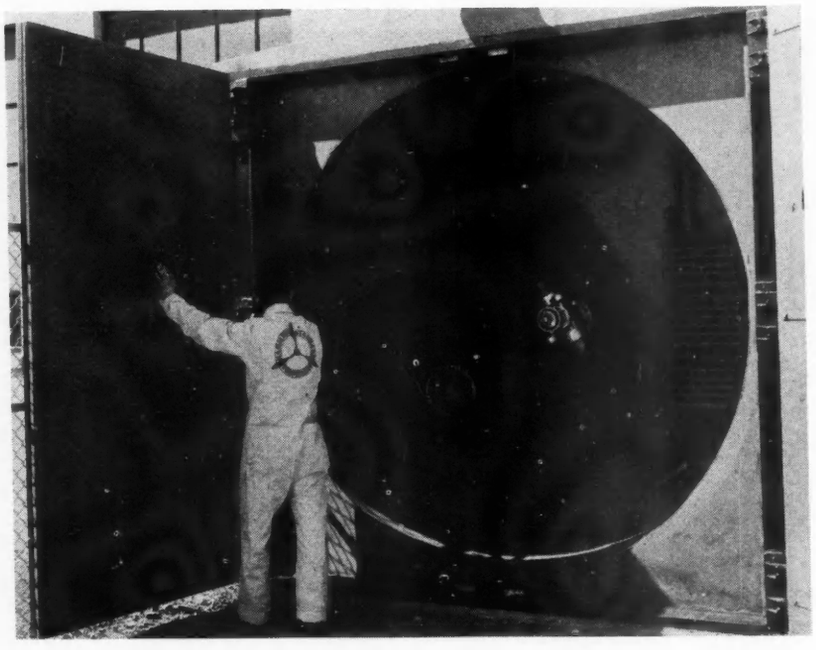
density of the air at different levels, governing the engine speed by adjusting the torque load, but its sensitivity must be such as to hold the powerplants of a multi-engined plane in synchronism in bumpy air, without hand throttling.

Erosion tests, in which sand, gravel, cinders or water may be projected into the whirling propeller, constitute another part of the test procedure. Still another is the rotation of propellers at much higher than normal speeds. This not only anticipates a possible future trend in plane design, but permits critical studies to be made of vibration and its effects on materials. It should be noted that both dynamic unbalance and aerodynamic unbalance (or difference in thrust of the individual blades), vary as the square of the rotational speed. Overspeed tests, therefore, produce highly informative data.

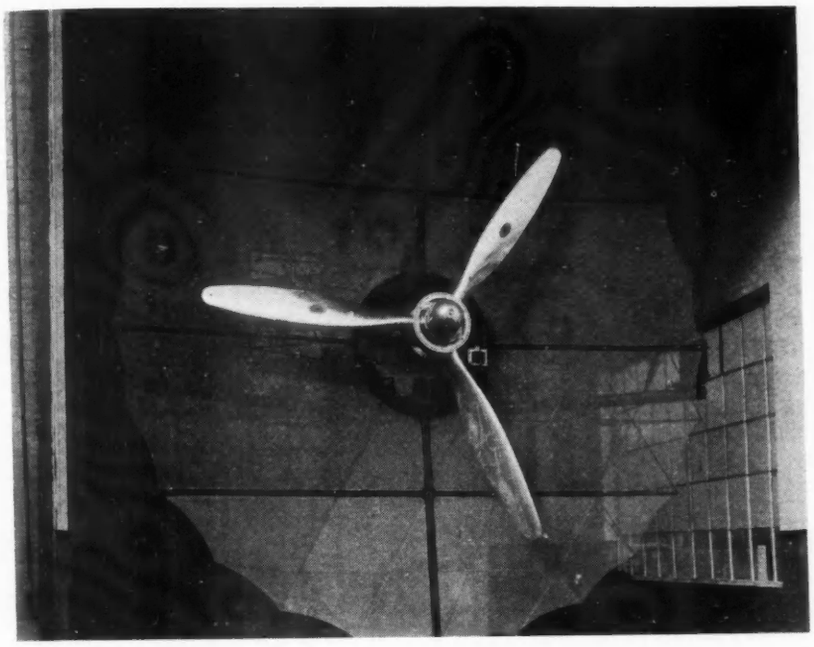
Sufficient equipment is now provided in the laboratory, which is steadily growing from year to year, so that numerous tests may be carried on simultaneously. Office quarters are provided for a good sized staff of engineers engaged exclusively in laboratory operation. The new building, recently completed, also includes a well equipped general engineering laboratory. Incorporated in the same structure is the cold room, which is 20 per cent larger than the original refrigerating building, erected two years ago. Adjoining are four experimental propeller test houses, built last year, which are of similar construction.

In each of these houses is a stand for mounting any airplane powerplant complete with propeller, together with the necessary provisions for complete running tests. All controls, as well as elaborate provisions for instrumentation, are led to sound-proof operating rooms, where the test engineers perform all adjustments and take any number of readings in an atmosphere free from strain, permitting communication at conversational levels. In view of the unpredictable hazards involved in some of the experimental work, the propeller test cells themselves are practicaly bomb-proof structures; operations are viewed from the control rooms through double windows of plate glass 1 in. thick.

Sound-proofing is provided not only for the comfort of the test engineers, but also for the public peace of mind. Though engines and propellers are thundering at above normal speeds, and air circulates freely through louvre-like walls of sound-deadening material at both ends, only a not disturbing hum is heard out-



The whirl rig chamber for conducting above-normal rotation speed, erosion and high temperature tests. Power is supplied from a 185 hp. engine in the control room



Aerodynamic balance of Hamilton propeller is determined by this wire-mesh web. When balance is perfect, the web remains stationary with the propeller rotating. Unbalance is indicated by web oscillation, which is measured electrically

side. So much energy is absorbed by the packing in the close-spaced longitudinal walls, however, as frequently to cause an appreciable rise in their surface temperature.

For the testing of propeller characteristics exclusively, several of the testing stands are provided with permanent motor drives, with shafts projecting into the test chamber, where the propeller is installed. This is true of the cold room, except that in this case the refrigerated chamber is also large enough to accommodate portable equipment, which can be rolled in from the outside through an air-lock. Such, for instance, is the portable governor-testing stand.

The so-called "whirl rig" also is equipped with outside drive and complete controls. This is a relatively short sound-proofed chamber, capable of accommodating a full-sized propeller, and provided with a heating coil, a stoker for feeding abrasive material into the propeller under test, and an exhaust stack. A blower supplies air up to 7000 cu. ft. per min.

By far the most elaborate, and probably the most important unit in the present laboratory equipment is the propeller balancing machine, which Hamilton Standard engineers consider one of their most satisfactory achievements. This equipment permits separate analyses of both dynamic and aerodynamic unbalance under a wide range of speed and other operating conditions. Like the other test rigs it has its own powerplant, isolated control desk and complete instrumentation, which are mounted centrally in the building, surrounded by streamlined airways which permit optimum access of air to the propeller undergoing test. The metering equipment associated with this rig is unique.

For measuring the effects of unbalanced mass in propeller operation an adaptation of the Dynetric balancing machine is used. This consists essentially of a balancing arbor mounted in two horizontally free journals and driven through a pair of universal joints. A magnetic pickup is located at each bearing, which reacts to the motion of the arbor, producing a voltage proportional to that motion. The electrical system to which the pickups are connected is calibrated to indicate the angular motion of the arbor in the horizontal plane. This is interpreted by the instruments as force or moment unbalance of the propeller. Both the magnitudes and angular locations of such forces are included in the indications.

Entirely separate from this part of the apparatus, but using the same pickups is the floating element used in determining aerodynamic unbalance. This consists of a non-revolving screen diaphragm, 16 ft. in diameter, of extremely light but rigid construction, which is pivoted vertically, and, therefore, free to rotate through a very small arc in the horizontal plane. This diaphragm is mounted in the wake of the propeller. As the diaphragm is symmetrical with respect to the propeller, any inequality in the thrust produced by the individual blades will cause it to oscillate. Such oscillations, when translated by the instruments into alternations in voltage are capable of interpretation, as in the case of the forces due to unbalanced masses, in terms of frequency and angular location.

Test procedures and equipment outlined thus far have concerned the integrity of the propeller structure exclusively. The mating of propeller and powerplant, however, introduces further problems which are solved by methods derived from the same basic analysis.

Aircraft powerplant balance has been refined to a point where major structural failures due to vibration from that source are no longer apprehended. Nevertheless, in addition to propeller vibratory stress measurements, determinations are made of the vibratory motion of the engine in space, as well as of its torsional crankshaft vibration, or both. Such investigations make it possible to study analytically the vibration characteristics of the engine-propeller combination, including the phase and amplitude relations of their major components.

Another important phase of the Hamilton Standard research program concerns the question how closely factory balance of propeller and powerplant systems are retained during the service life of the equipment. Laboratory studies of blade erosion bear directly on this problem from one point of view. Material lost in smoothing and polishing worn blades, normal wear of the governor mechanism and changes in bearing clear-

(*Turn to page* 67, *please*)

Powder Metallurgy...

By FLOYD C. KELLEY*

THE DEVELOPMENTS of the last 30 years in the field of powder metallurgy have kept pace with the accumulation of scientific knowledge, and it is during this period that research has contributed so much to our comfort and standard of living. Outstanding contributions during this period include ductile tungsten, porous bearing material, copper-impregnated tungsten material now used so extensively as an electrode for spot and line welding, cemented tungsten carbide, and the appearance of other mixed carbide tool materials such as tungsten carbide - tantalum carbide, tungsten carbide-titanium carbide, and tungsten, tantalum, and titanium carbides.

Sintered Alnico, developed by General Electric Co. Research Laboratory, is one of the most recent permanent magnetic materials and generally is made from Al, Ni, Co, and Fe. Cast Alnico develops a large grain structure, is brittle, and has low impact resistance, but the fine-grained, sintered material is strong and has a relatively high resistance to shock.

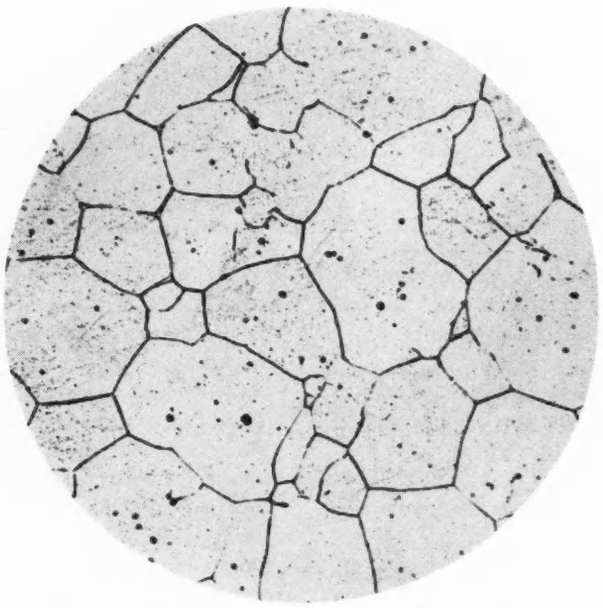


Fig. 1—Sintered nickel from hydrogen reduced nickel oxide. Note the equiaxed grain structure.

The automotive industry has used oil-impregnated bronze bearings for years, but more recently Moraine Products (General Motors) and Amplex (Chrysler) have produced bearings from sintered iron compositions. They have also extended their application to the production of oil pump gears, door catches, cams, filters and other parts.

Oil-impregnated bearings can be turned out by automatic machines by the million, sintered in an atmosphere-controlled, continuous-operating, automatic temperature-controlled type of furnace where the product to be sintered goes into one end and comes out the other a finished product except for the oil impregnation. There are many cases where tolerances are close which demand a cold coining operation.

Iron parts to which carbon or graphite have been added may be sintered at a sufficiently high temperature to bring about diffusion of the carbon or graphite into the iron, thus forming steel. Iron may be bound together with copper in the same manner. The parts containing carbon may be heat treated in the same way as steel articles made from fused metal which has been cast and worked.

Many applications do not require material with high physical properties, but lubrication to prevent wear may be the only requirement. Some ores from which iron powder is made contain impurities such as silicates and high phosphorus which enhance the wear resisting characteristics. The porosity of the compressed compact is controlled by the amount of pressure applied and the temperature and time of sintering.

The work done on hot-pressed brake drums at Chevrolet Gear and Axle, where steel scrap made sufficiently fine by grinding so it could be cold pressed, sintered, and then reheated and hot pressed into a die, is one of the outstanding pieces of work in this field. These drums have been made and tested in actual service and found to be as good as or better than those formed from wrought material. The development of such a process naturally depends upon the cost of putting the scrap into such condition that it can be easily formed in a die.

The limitations of powder metallurgy naturally depend upon the availability and cost of the material. The material commonly used for this work was Swedish sponge iron because of its quality and cost. That source has now been cut off, but there are many firms making powdered iron in America which can be used for this production if the cost can be reduced to, say, 50 to 10 cents per lb.

Powders when pressed do not flow around corners as do many plastic materials, and because of this the design of the part being formed is very important. The plungers operate in straight lines; and in order to withdraw the plunger or eject the compact after forming without breakage of the compact, the design of the die and compact must be correct.

There are many automatic machines of the pill machine type being used today to turn out small parts, but as the size of the part increases, the machine tool

(*Turn to page* 56, *please*)

* Abstract of a paper read at a recent meeting of the Engineering Society of Detroit by Mr. Kelley of the General Electric Research Laboratory.

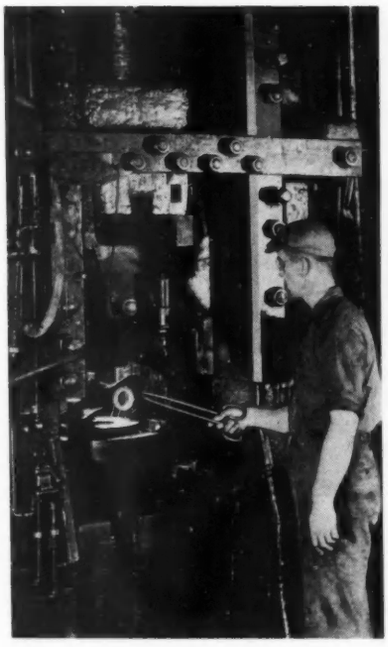
Applications in Mass Fabrication of Automobile Parts, Its Possibilities and the Results of Some Current Research Investigations in This Rapidly Expanding Field of Sintered Metals Are Presented Here

By HERBERT CHASE

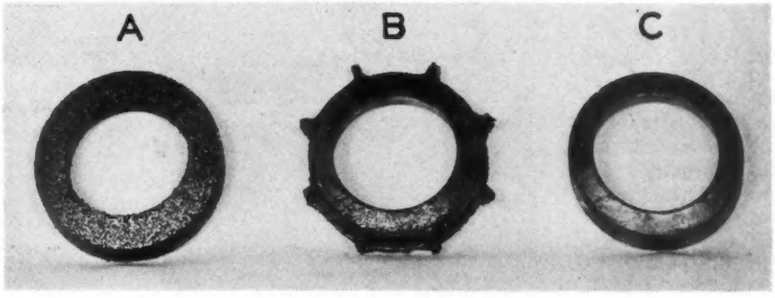
A NEW method of producing a special form of bearing sleeve is credited to the ingenuity of Herman Tormyn and his associates of the Chevrolet Gear and Axle plant, Detroit. Although called a "sleeve," the part might more aptly be termed an annular spacing and adjustment ring, as it is used, not as a bearing, but to space and adjust one bearing for the pinion in certain Chevrolet axles. As the drawing indicates, one face of the ring is tapered. It makes contact with the tapered point of three radial adjusting screws so set as to move the ring axially in effecting bearing adjustment.

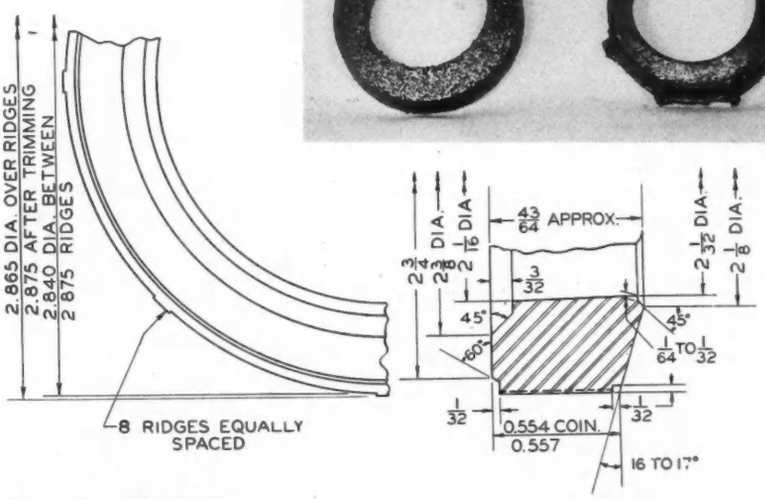
Until recently, this ring was a gray iron casting which required considerable machine work, and production of the ring in the new form has eliminated the last gray iron casting from the products of the Gear and Axle plant. Now the ring is made from chips of X-1112 steel coming from the screw machine department of the same company. The chips are not specially cleaned, but are given the same treatment for recovery of coolant applied to all chips from that department. They are prepared for use by running them through a shreader, a type of hammer mill which breaks the chips into particles and flakes of mixed sizes. These are shoveled into the hopper of a bricquetting press of 600-ton capacity and enter a die which forms a ring bricquette having about one-third the loose volume of the chips fed to the die. The pressure applied is about 30 tons per sq.in. and the bricquettes must weigh 8¾ oz. within a tolerance of ¾ oz. Production is 720 an hour.

In this form, the briquettes have little strength but enough to permit of handling in placing them, one at a time, on carriers to be passed through a continuous electric furnace adjacent to the press in which they are made. In the furnace, which has a reducing atmosphere, the briquettes attain a temperature of 1950 to 2060 deg. Fahr., (*Turn to page 60, please*)



Delivery end of a sintering furnace and the press at the Chevrolet Gear and Axle plant, in which the heated briquette is subjected to final forming under a pressure of 30 to 50 tons per sq. in.





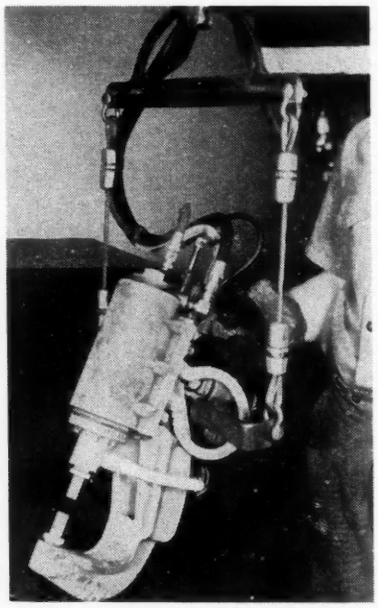
Steps in making Chevrolet sintered sleeve. (a) Briquette after compressing granulated steel chips. (b) Sintered and pressed sleeve as it appears before flash removal. (c) After flash has been cut away and part coined.

Dimensional limits which must be held in the finished sintered sleeve after coining and shot blasting.

MEN

As a result of demand from the aircraft industry for portable resistance spot welding equipment for tack and assembly welding of sections in fixtures where the work cannot be taken to stationary pedestal welders, Progressive Welder Co., Detroit, has developed a portable welding gun specifically designed for resistance spot welding of aluminum. The air-operated gun with its transformer may be used with virtually any control equipment for welding aluminum. The complete mechanism is built into the gun head.

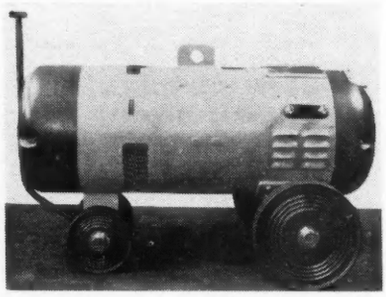
The manually-controlled point-retracting mechanism permits the retrac-



Progressive portable resistance welder.

tion of one electrode for a maximum of 4 in. The new gun is designed for the application of refrigeration to the welding tips, which effects a marked increase in the number of operations before the points need redressing. For structural spot welding of aluminum, the gun will handle up to two pieces .040 in. thick. For tack welding, greater thicknesses can be handled.

A new all-purpose portable flexarc welder has been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. In this model a mechanism operated by a crank on the end of the machine makes it possible to choose the desired current before welding. By the addition of a magnetic shunt, the need for a field rheostat or an external reactor is eliminated. This welder is furnished in ratings of 200, 300, or 400 amperes for operation on



Westinghouse's new portable welder with arc control and preset current adjustment.

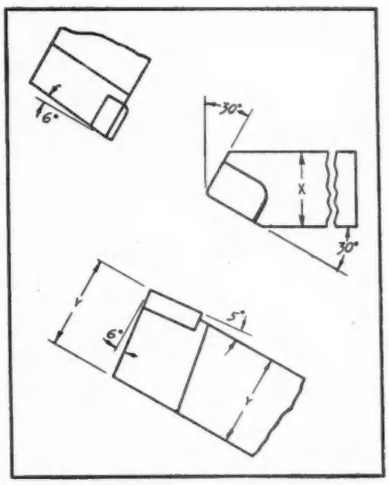
two- or three-phase 220-, 440-, or 550-volt A-C circuits of 25, 50, or 60 cycles. Standard driving motors are of the squirrel-cage induction type.

A rapid and convenient method for analyzing spectographic plates or films in research and industrial laboratories is provided by a new recording microphotometer being manufactured by Leeds & Northrup, Philadelphia, Pa. The plates or films are mechanically scanned by a motor-driven scanning unit, and the relative positions and densities of the spectrum lines are automatically recorded by an L&N Speedomax Recorder. The scanning unit is designed to accommodate plates or films as large as 4 in. wide by 10 in. high.

Leeds & Northrup Microphotometer for recording spectrum-line densities.

Quick determinations of elements present in small percentages are made possible by pen-and-ink records of standard and test spectrograms drawn at high speed on one chart.

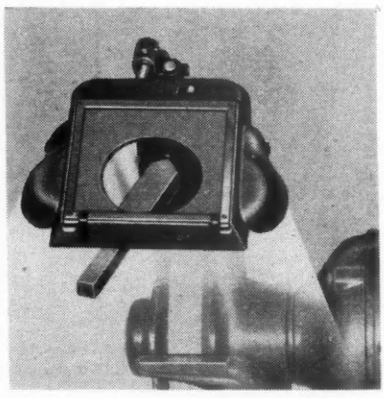
A new standard series of Kennametal tools in large turning and facing styles for heavy machining has been developed by the McKenna Metals Co., Latrobe, Pa. The position of the tip in the shank permits a greater thick-



New tip design of Kennametal tools.

ness of steel under the cutting point of the tip, and allows a large portion of the top surface to be ground without removing steel from the shank. Tools of this design are available in all turning and facing styles, and in all shank sizes of 1-in. and larger.

Two types of illuminated eye shields were announced recently by the Hisey-Wolf Machine Co., Cincinnati,

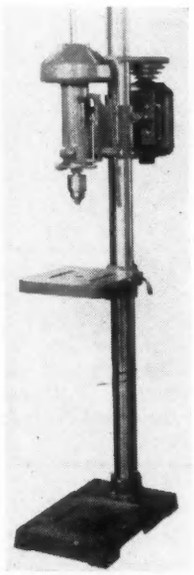


Illuminated eye shields announced by Hisey-Wolf Mach. Co.

and MACHINES

Ohio. Each shield is equipped with two lamps fitted with rough-service bulbs. One is equipped with a 4½-in. magnifier offering 2-power magnification at a focal length of 10 in. The other is constructed of shatterproof glass with plain glass underneath. This shield is furnished in two sizes, 9 by 7 in. for 12-in. wheels and larger, and 5 by 7 in. for 10-in. wheels and smaller.

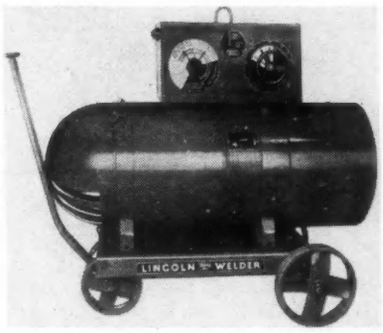
THE TAYLOR MFG. CO., Milwaukee, Wis., has announced its new Model F-400 "Hi-Duty" Drilling Machine. This new unit is available in either



Model F-400 drilling machine built by Taylor Mfg. Co.

bench-type or floor-type models, with or without motor. It is furnished completely assembled. Standard equipment includes a Jacobs chuck accommodating drills from 1/32 in. to ½ in. The four spindle speeds range from 860 to 3450 r.p.m.

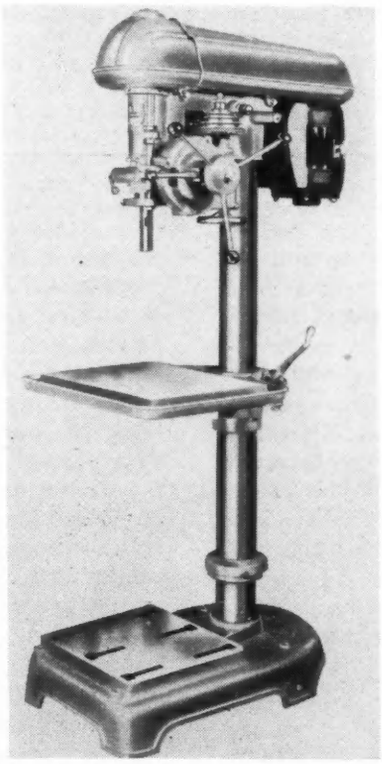
AN IMPROVED and simplified design of its system of "Dual Continuous Control" for arc welding machines is announced by the Lincoln Electric Co., Cleveland, Ohio. On these welders both the job selector and the current control are calibrated to indicate the type of work and the number of amperes for each setting. This feature enables the operator to vary both the slope of the volt-ampere curve and the amount of welding current to suit every job. The control can be advanced or re-



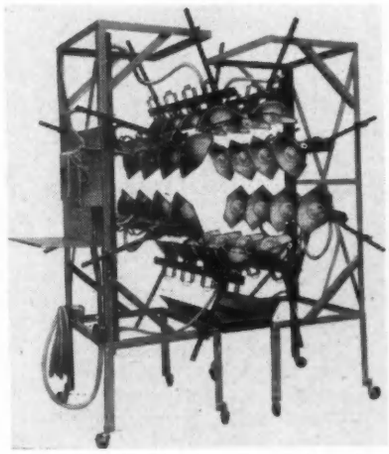
Improved control on Lincoln arc welder eliminates need for meter.

tarded in increments as fine as desired. The polarity-changing switch, located in the space formerly occupied by the meter, is a feature of this new design.

THE WALKER-TURNER CO., INC., Plainfield, N. J., announces a new 20-in. drill press which is designed for power-, foot-, or hand-feed application. The power-feed unit, which consists of a worm drive with a built-in clutch, is driven directly from the drill press spindle. Four rates of speed are provided for each of the five spindle speeds. An easily-read chart shows the rate of feed in .001 in. per revolution of the spindle. The machine is equipped with a No. 2 Morse taper spindle nose. It is available in single- or four-spindle models.



Walker-Turner 20-in. power feed drill press.



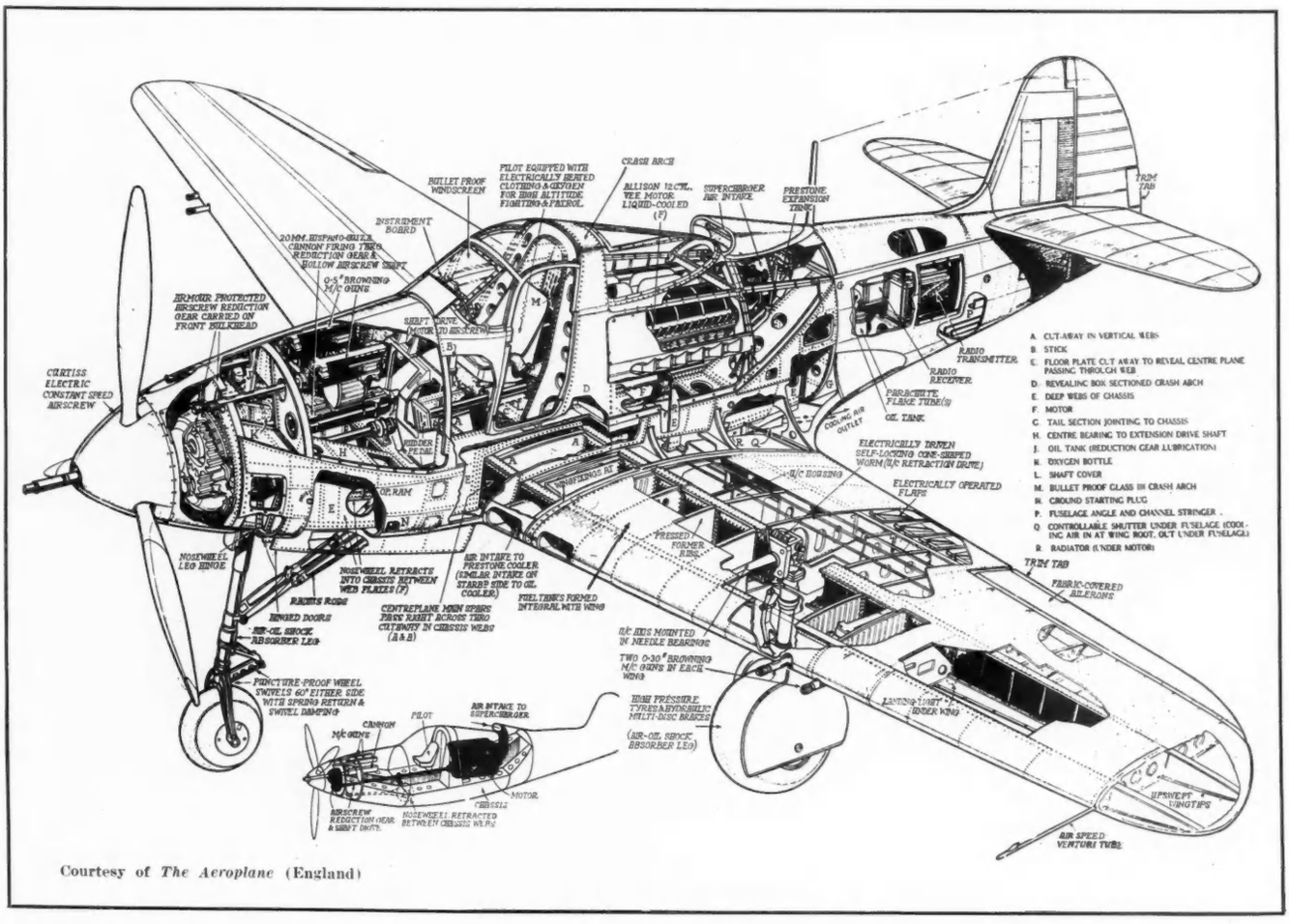
Fostoria baking unit, Model MBU-832-QR.

THE FOSTORIA PRESSED STEEL CORP., Fostoria, Ohio, is offering two electric motor-baking units, Model MBU-832-QR, and Model MBU-416-IR. Model MBU-832-QR has 32 Para-Sphere reflectors mounted on the flexible-arm frame and it will accommodate parts up to 37 in. in diameter. Using 250-watt lamps, the total load is 8 kw. Model MBU-416-IR uses 16 reflectors. Each arm is wired separately, consequently any combination of arms may be used.

A HIGHLY improved second-operation machine, known as the Pacific Vera-Lathe, has been introduced by the Pacific Tool & Die Co., Los Angeles, Cal. It features spindle speeds from 1250 to 5000 r.p.m., a hollow-spindle design, and a novel collet-operating mechanism which permits the operator to insert and remove his work while the machine is running. This collet may be foot-operated if desired. The ball-bearing mounted spindle incorporates a hollow draw tube which accommodates a collet with a maximum capacity of ¾ in.

(*Turn to page 72, please*)

Bell Airacobra I in Britain


A. CUT-AWAY IN VERTICAL WEBS
B. STICK
C. FLOOR PLATE CUT AWAY TO REVEAL CENTRE PLANE PASSING THROUGH WEB
D. REVEALING BOX SECTIONED CRASH ARCH
E. DEEP WEBS OF CHASSIS
F. MOTOR
G. TAIL SECTION JOINTING TO CHASSIS
H. CENTRE BEARING TO EXTENSION DRIVE SHAFT
J. OIL TANK (REDUCTION GEAR LUBRICATION)
K. OXYGEN BOTTLE
L. SHAFT COVER
M. BULLET PROOF GLASS IN CRASH ARCH
N. GROUND STARTING PLUG
P. FUSELAGE ANGLE AND CHANNEL STRINGER
Q. CONTROLLABLE SHUTTER UNDER FUSELAGE (COOLING AIR IN AT WING ROOT, OUT UNDER FUSELAGE)
R. RADIATOR (UNDER MOTOR)
TRIM TAB
FABRIC-COVERED AILERONS
UPSWEPT WINGTIPS
AIR SPEED VENTURI TUBE
RADIO TRANSMITTER
RADIO RECEIVER
PARACHUTE FLARE TUBE(S)
OIL TANK
COOLING AIR OUTLET
ELECTRICALLY DRIVEN SELF-LOCKING CONE-SHAPED WORM (U/C RETRACTION DRIVE)
U/C HOUSING
ELECTRICALLY OPERATED FLAPS
PRESSED FORMER RIBS
U/C AXIS MOUNTED IN NEEDLE BEARINGS
TWO 0·30" BROWNING M/C GUNS IN EACH WING
LANDING LIGHT IN UNDER WING
HIGH PRESSURE TYRES & HYDRAULIC MULTI-DISC BRAKES
(AIR-OIL SHOCK ABSORBER LEG)
FUEL TANKS FORMED INTEGRAL WITH WING
AIR INTAKE TO PRESTONE COOLER (SIMILAR INTAKE ON STARBD SIDE TO OIL COOLER)
CENTRE PLANE MAIN SPARS PASS RIGHT ACROSS THRO CUTAWAY IN CHASSIS WEBS (A & B)
NOSEWHEEL RETRACTS INTO CHASSIS BETWEEN WEB FLANGES (F)
RADIUS RODS
HINGED DOORS
AIR-OIL SHOCK ABSORBER LEG
NOSEWHEEL LEG HINGE
PUNCTURE-PROOF WHEEL SWIVELS 60° EITHER SIDE WITH SPRING RETURN & SWIVEL DAMPING
AIR INTAKE TO SUPERCHARGER
PILOT
CANNON
M/C GUNS
MOTOR
CHASSIS
AIRSCREW REDUCTION GEAR & SHAFT UNITS
NOSEWHEEL RETRACTED BETWEEN CHASSIS WEBS
CURTISS ELECTRIC CONSTANT SPEED AIRSCREW
ARMOUR PROTECTED AIRSCREW REDUCTION GEAR CARRIED ON FRONT BULKHEAD
20 MM. HISPANO-SUIZA CANNON FIRING THRO REDUCTION GEAR & HOLLOW AIRSCREW SHAFT
0·5" BROWNING M/C GUNS
SHAFT DRIVE TO AIRSCREW
INSTRUMENT BOARD
BULLET PROOF WINDSCREEN
PILOT EQUIPTED WITH ELECTRICALLY HEATED CLOTHING & OXYGEN FOR HIGH ALTITUDE FIGHTING & PARACHUTE
CRASH ARCH
ALLISON 12 CYL., VEE MOTOR LIQUID-COOLED (F)
SUPERCHARGER AIR INTAKE
PRESTONE EXPANSION TANK
TRIM TAB

Courtesy of *The Aeroplane* (England)

FROM England comes this detail drawing and description of the Bell Airacobra now in service with the R.A.F., which has designated it the Airacobra I. The U. S. Army version, similar in design to the R.A.F. fighter, is known as the P-39D.

Its armament consists of a 20-mm. Hispano cannon protruding from the spinner, two .50-cal. Browning machine guns on top of the fuselage and synchronized to fire between the propeller blades, and four .30-cal. Browning machine guns in the wings. The original design had a 37-mm. cannon, but it later was replaced by a 20-mm. cannon because of the latter's higher rate of fire, which is more advantageous in combat. The 37 mm. cannon has a rate of fire of only 85 rounds per min. as compared to 600 rounds per min. for the 20 mm. cannon. All of the guns are said to be aimed through the same reflector sight.

Comprising the airframe are 13 main assemblies and 100 sub-assemblies. The fuselage design changes at the rear of the engine, which is located just behind the cockpit. At the rear, fuselage construction is the conventional oval monocoque type. The forward section is built on a chassis that has two main box girders extending from the propeller reduction gear to just behind the engine.

The cooling system for the engine is credited with being the best installation of its type. Ducts in the wing root extend to the radiator which is located in the center of the fuselage underneath the engine. Major specification data are listed as follows:

Dimensions—Span, 34 ft.; length, 34 ft. 2 in.; height, 9 ft. 3¼ in.; wing area, 213 sq. ft.; aspect ratio, 5.4; propeller diameter, 10 ft. 4½ in.

Weights—Empty, 5360 lb.; loaded 7380 lb.; wing loading, 34.65 lb. per sq. ft.

Engine—Allison V-1710-E4, 12-cylinder liquid cooled; take-off output, 1150 hp. at 3000 r.p.m.; fuel consumption, 44.5 U. S. gal. per hr. at 25 in. manifold pressure (—2½ lb. boost); capacity of fuel tanks, 120 U. S. gal.; oil capacity 17 U. S. gal.

Automotive MATERIALS 58

Union Bay State Co. Offers Neoprene Cements

OF UNUSUAL interest is a new line of neoprene adhesives and coatings developed by the Union Bay State Co., Cambridge, Mass. Called N Series (neoprene base) cements, they are particularly suited to the cementing of fabrics to metal, rubber to metal, and fabrics to rubber. They are also recommended for cementing molded synthetic rubber products together, or to metals. Applied as a protective coating to fabrics, metals, and other materials, they furnish resistance to heat, chemicals, gasoline, oil, air, and sunlight. In this respect these cements resemble closely their parent product, neoprene. Vulcanizing is achieved within 72 hours at normal room temperature. Non-thermo-plasticity is reached within 2 to 4 weeks after application.

As shipped, N Series Cements when stored without refrigeration remain liquid for from 7 to 8 months. After being mixed with their vulcanizing agents, they remain usable for 24 hr. instead of the usual 8 hr. The tack is ready for joining after 10 to 15 minutes of application.

Heat Treated Spring Steel Makes Good Armor

IT IS altogether probable that U. S. Army and Navy pilots will soon be flying in planes protected by light armor made from a steel which the automotive industry has been using for years in the manufacture of automobile springs. Preliminary studies by steel plant metallurgists show that this type of steel may be adapted to the production of armor plate merely by applying new heat treating methods, and by introducing certain other variations from peacetime practice.

Houghton Develops Rapid Quench Oil

BECAUSE a rapid quench is essential in the heat treatment of high-explosive shells, E. F. Houghton & Co., Philadelphia, Pa., manufacturer of oils and heat-treating materials, has developed a new quenching oil known as Houghto-Quench "G" for that purpose. This oil was compounded to meet a predetermined range of physical properties. Houghto-Quench "G" is reported to have a desirable flash point and viscosity, does not sludge appreciably, and is quite stable. Included in its make-up is a chemical agent which acts as a stabilizer, which also reduces oxidation or fractional distillation. A synthetic wetting agent is also embodied in Houghto-Quench "G" to provide rapid wetting-out properties. In this way the formation of gas pockets is prevented.

Saran Plastic Fabric for Car Upholstery

A NEW woven plastic fabric which is stainless, flexible, tough, and non-inflammable is being manufactured by the Firestone Tire & Rubber Co., Akron, from Saran, a thermoplastic resin material of the Dow Chemical Co. At present its most important use is in the upholstery of automobiles, buses, airplanes, and other transportation units where the seating receives exceptionally hard wear. It is now in experimental service on the New York subways. Saran can be used to reproduce almost any weave of cotton, wool, rayon, or silk. It may also be used in combination with any of these fabrics to produce highly original patterns and weaves. When formed in sheets, Saran can be used for airplane partitions, table tops, and many small component parts. It is easily cleaned with a damp cloth.

Fibrated Leather Gasket Material

A NEW fibrated-leather gasket material having the natural advantages of leather has been introduced by the Industrial Division of the Armstrong Cork Co., Lancaster, Pa. Known as Armstrong's No. 841, this material is recommended for sealing oil, water, and gasoline. It may be used in other applications where the temperatures do not exceed 300 deg. Fahr., and where acids or alkalis are not encountered. The company supplies it in rolls and sheets in standard widths up to 48 in., but also is equipped to handle orders for shapes die-cut to specifications.

Weldcraft Is New Decorative Finish

WELDCRAFT, a new type of surface finish found to be an excellent substitute for colored plastics, chrome plating, and other decorative preservatives, is being marketed by Parker-Wolverine Co., Detroit. Weldcraft is actually an enamel which can be supplied in a transparent form for the coating of bright metals, die castings, and electro-plated surfaces, and in an opaque form for the surfacing of either plastics or metals. According to Charles W. Awkerman, president of Parker-Wolverine, Weldcraft is offered primarily as a finish for interior automobile hardware, although it can be used for exterior surfaces as well. It is obtainable in any color. After being sprayed with the desired color, the coated object is placed in a baking oven. Upon removal, the surface of the object is said to resemble that of a die-cast plastic.

Saran plastic fabric for replacing conventional upholstery materials.

Transfer of Load Due to Braking in Tractor-Trailer Combinations

By P. M. HELDT

NEARLY ten years ago there appeared in AUTOMOTIVE INDUSTRIES an article dealing with the weight transfer in tractor-semi-trailer combinations due to brake application. At that time comparatively few such combinations had brakes on the trailer wheels, and only two cases were considered, those of brakes on the tractor rear wheels only, and of brakes on all four tractor wheels. At the present time practically all tractor-trailer combinations are equipped with brakes on all wheels, and this case, therefore, is of much more importance than either of the other two. The transfer of weight when brakes on all wheels are applied to near the locking point will be considered in the following. We will make use of the following abbreviations:

W, weight of tractor.

W_1, weight of loaded trailer.

R_1, R_2 and R_3, reactions of ground on tractor front and rear and trailer wheels when brakes are applied.

R_3, reaction to load on bolster of tractor when brakes are applied.

B and B_1, retarding forces on tractor and trailer, respectively.

H, height of center of gravity of tractor.

H_1, height of center of gravity of trailer.

h, height of coupling between tractor and trailer.

L, wheel base of tractor.

L_1, horizontal distance from center of coupling to center of trailer axle.

l_1, horizontal distance from front axle to center of gravity of tractor.

l_2, horizontal distance from rear axle to center of gravity of tractor.

l_3, horizontal distance from center of coupling to center of gravity of loaded trailer.

l_4, horizontal distance from trailer axle to center of gravity of loaded trailer.

μ, coefficient of friction between tire and pavement.

In the drawing the bolster is shown located directly above the rear axle. In practice it is usually a few inches ahead of the rear axle, but this has little effect on the shifting of weight due to brake application and will be neglected.

The total retarding force is equal to $(W + W_1)\ \mu$, and this is opposed by an equal inertia force, to which the tractor contributes $W\ \mu$ and the trailer, $W_1\ \mu$. These inertia forces, of course, act at the centers of gravity of the tractor and trailer, respectively.

We will first determine the load on the trailer axle when the brakes are applied. As already indicated, under these conditions the inertia force on the tractor is $B = W\mu$

and that on the trailer, $B_1 = W_1\mu$

Since the trailer wheels carry only part of the weight of the trailer and the tractor wheels carry more than the entire weight of the tractor, it is obvious that when the brakes are applied the retarding force at the tractor wheels is greater than the inertia due to the tractor weight, while, on the other hand, the retarding force on the trailer wheels is less than the inertia due to trailer weight, hence under braking conditions the trailer will be exerting a forward force on the tractor through the coupling. Since the inertia due to the trailer weight is $W_1\ \mu$, and the retarding force at the trailer wheels is $R_4\ \mu$, the horizontal force on the coupling is $(W_1 - R_4)\ \mu$.

There are evidently five forces acting on the trailer when the brakes are in action, viz., an upward reaction R_3 at the coupling, a rearward reaction $(W_1 - R_4)\ \mu$ at the coupling, the force of gravity W_1 at the center of gravity, the force of inertia $W_1\ \mu$ acting forward at the center of gravity, and the retarding force $R_3\ \mu$ acting rearward at the point of contact between tire and road. The first four of these forces produce moments around a transverse axis through the points of ground contact of the trailer wheels. Since the trailer is in equilibrium, these moments must reduce to zero, and we, therefore, have

$$R_3 L_1 + (W_1 - R_4)\ \mu h - W_1 l_4 - W_1 \mu H_1 = 0$$

Also,

$$R_3 + R_4 = W_1, \text{ so that } R_3 = W_1 - R_4$$

Making this substitution for R_3 in the equation of moments and transposing we get

$$W_1 L_1 - R_4 L_1 - R_4 \mu h = W_1 (l_4 + \mu H_1 - \mu h)$$

$$W_1 (L_1 + \mu h - l_4 - \mu H_1) = R_4 (L_1 + \mu h),$$

and

$$R_4 = W_1 \left(\frac{L_1 - l_4 + \mu h - \mu H_1}{L_1 + \mu h} \right)$$

and since $R_3 = W_1 - R_4$,

$$R_3 = W_1 \left(1 - \frac{L_1 - l_4 + \mu h - \mu H_1}{L_1 + \mu h} \right)$$

$$= W_1 \left(\frac{l_4 + \mu H_1}{L_1 + \mu h} \right)$$

Turning now to the tractor, we find that there are six forces acting on it, as follows:

Supplementing an earlier article on this same subject, this new data is pertinent to the latest developments in tractor-trailer design

The inertia force $W\mu$ acting forwardly at the center of gravity.

The force of gravity W acting downwardly at the center of gravity.

The push of the trailer $(W_1 - R_4)\mu$ acting forwardly at the coupling.

The reaction R_1 acting upwardly on the front wheels.

The reaction R_2 acting upwardly on the rear wheels, and the brake retarding force $(R_1 + R_2)\mu$ acting rearwardly along the axis of the tractor projected on the road surface.

Of these six forces the first four create moments around a transverse axis through the centers of ground contact of the tractor rear tires. Again the moments must cancel out, and we, therefore, have

$$R_1 L = W l_2 + W\mu H + (W_1 - R_4)\mu h$$

from which it follows that

$$R_1 = \frac{W(l_2 + \mu H) + (W_1 - R_4)\mu h}{L}$$

As an expression for R_4 in terms of known factors has been given already, all of the items appearing in the right-hand side of the foregoing equation may be considered known, and R_1, therefore, can be calculated.

Since

$$R_1 + R_2 + R_4 = W + W_1$$
$$R_2 = W + W_1 - R_1 - R_4$$

To give an idea of the magnitude of the weight shifting in a tractor-trailer combination we will apply the equations derived to the following case:

$W = 6000$ lb. $\quad L_1 = 180$ in.
$W_1 = 24{,}000$ lb. $\quad l_4 = 80$ in.
$L = 140$ in. $\quad H_1 = 65$ in.
$l_2 = 75$ in. $\quad h = 35$ in.
$H = 28$ in. $\quad \mu = 0.6$

Then

$$R_4 = 24{,}000\left[\frac{75 + (0.6 \times 35) - 80 - (0.6 \times 65)}{180 + (0.6 \times 35)}\right] = 9{,}800 \text{ lb.}$$

$$R_1 = \frac{6000\,(75 + 0.6 \times 28) + (24{,}000 - 9{,}800)\,0.6 \times 35}{140} = 6{,}050 \text{ lb.}$$

$$R_2 = 30{,}000 - 9{,}800 - 6{,}050 = 14{,}150 \text{ lb.}$$

The following table shows the load distribution between the various wheels for the above tractor-trailer combination under static conditions, with brakes applied to the tractor rear wheels only, with brakes on all four tractor wheels, and with brakes on all wheels, respectively.

Weight Distribution in Tractor-Semi-Trailer Train

	Static	Brakes on tractor rear wheels only	Brakes on four tractor wheels	Brakes on all wheels
Tractor front wheels.	3,210	5,025	5,815	6,050
Tractor rear wheels..	13,440	12,620	12,285	14,150
Trailer wheels	13,350	12,355	11,900	9,800
Total	30,000	30,000	30,000	30,000

Therefore, in this particular case, the maximum braking effects (or rates of retardation) obtainable with the three systems, respectively, are in the following proportions:

Tractor rear brakes
13.5
Four-wheel brakes
18
All-wheel brakes
30

The transfer of weight from the trailer axle to the bolster and from the tractor rear axle to the tractor front axle decreases with the heights of the centers of gravity of trailer and tractor, respectively, and as their wheelbases increase.

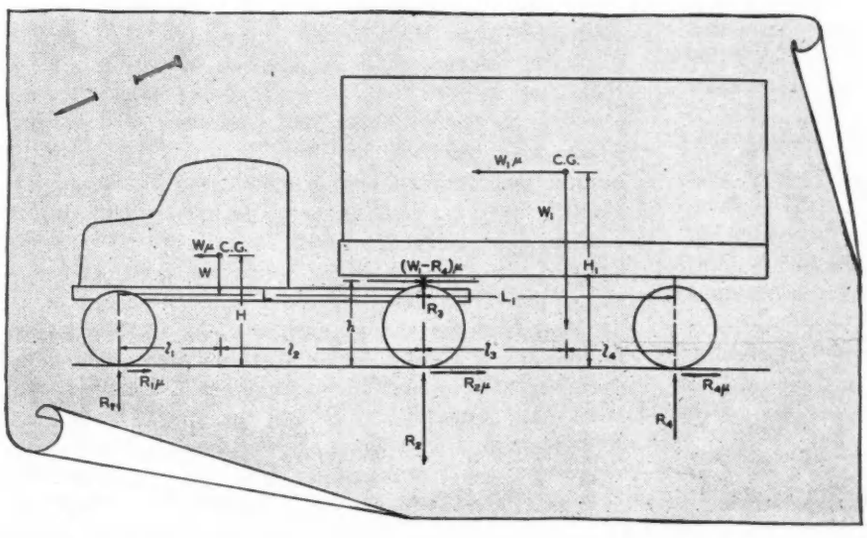
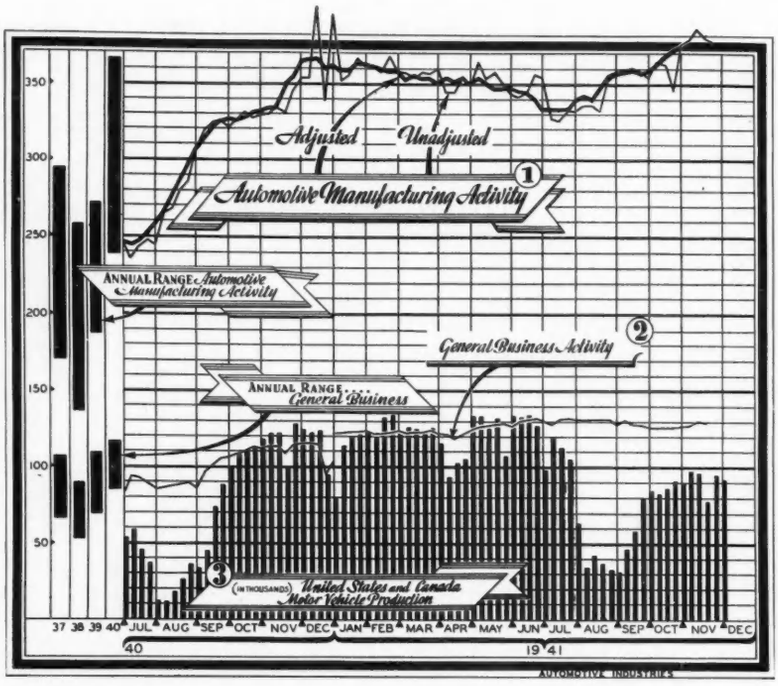


Diagram of tractor and trailer

[*Our own view of automotive production and sales; authoritative interpretation of general conditions*]



Weekly Indexes of Automotive General Business

December Production Revised Downward

DESPITE a more drastic curtailment imposed on passenger car production beginning Dec. 1, output for the first half of the month is estimated at 200,000 units. However, assemblies in the last 15 days of the month are not likely to top 100,000 vehicles, as most manufacturers plan to close down between Dec. 19 and Dec. 24 and remain closed until about Jan. 5. This compels them to concentrate their production in the first three weeks of December.

The 10-day to two-week shutdown over the Christmas and New Year holidays will enable the plants to make the necessary changeover in production facilities from models with brightwork to those with painted and enameled trim. Several companies have shown their 1942 "Series B" models without brightwork and the effect on the whole is pleasing, with no appreciable loss of eye appeal. Painted grilles, molding and trim and enameled hub caps replace previous bright metal parts. Only bumpers, locks, windshield wiper blades and window latches retain their chrome under the OPM order effective Jan. 1.

December passenger car output originally was limited to 204,848 units by OPM, a decline of 48.4 per cent from the same month in 1940, but the declaration of war on Japan made it necessary to cut output further after Dec. 15. Production for the last half of the month has been cut 25 per cent from the previous quota. January passenger car quotas have been cut 50 per cent from those originally set by OPM, making the month's total 102,424 units. This is a cut of 75.5 per cent from the 418,350 U. S. passenger cars produced in January, 1941. Further revisions in quotas which had been set through February will be made after an appraisal of the situation on strategic materials. Output in the week ending Dec. 8 was estimated at 91,500 units. GM turned out 33,400 vehicles, Chrysler accounted for 18,400 and Ford manufactured 21,600. Studebaker led the independents, followed by Willys, Nash, Hudson and Packard. Willys output was confined to ¼-ton combat cars. December will see an appreciable drop from the 379,070 vehicles produced in November, according to an Automobile Manufacturers Assn. estimate.

War in the Pacific and the consequent inaugural of the $150 billion all-out victory program will severely accentuate material shortages, especially in such vital automotive components as steel, copper, and rubber. More than 95 per cent of the U. S. crude rubber supply emanates from Malaya and the Dutch East Indies. U. S. inventories stood at 454,711 long tons Nov. 1, including 265,739 tons in government stockpiles, according to the Rubber Manufacturers Association. Stocks may reach 600,000 tons by Jan. 1. In 1940 the automotive industry used 518,800 tons of rubber, including replacement tires, or 80 per cent of the rubber consumed in the U. S.

Retail sales in November continued slow. GM consumer deliveries totaled 126,281 units, a decline of 30 per cent from the same month of 1940, and the lowest for the month since 1937, although an increase of more than 20,000 units over the October total. Early reports from 110 principal cities for the first 23 days of November showed a drop of 10 per cent in new passenger car registrations compared to the same period

(*Turn to page* 48, *please*)

[1] 1923 average = 100; [2] Prepared by Administrative and Research Corp. of New York to Jan. 1, 1941, and *New York Times* weekly business index after that date; [3] Estimated at the Detroit office of AUTOMOTIVE INDUSTRIES.

Critical Materials and the War with Japan

British Malaya and Dutch East Indies Are Sources of Rubber, Tin, Tungsten, Tung Oil and Manganese

Rubber, tin, tungsten, tung oil and manganese are the principal strategic materials used by the automotive industry which are affected by the outbreak of war with Japan in the Pacific. Use of alternate materials and other sources of supply make it possible for the industry to get along without these shipments except for rubber.

More than 95 per cent of the world's rubber is grown in British Malaya and the Dutch East Indies. U. S. stockpiles of crude rubber are expected to reach 600,000 long tons by Jan. 1. However, defense uses, such as military vehicle and aircraft tires, self-sealing fuel tanks, barrage balloons and tank treads are taking an increasingly larger part of the rubber available. One of the large rubber companies estimated recently that 27 per cent of its rubber stock was going into defense materials. This presages a cut in rubber allotments for passenger car manufacture and tires.

Four synthetic rubber plants have been financed by the government but the first of these are barely getting into production and total output when they are completed will be only 40,000 tons annually. Defense needs will take virtually this entire output.

Passenger cars required an estimated 3½ lb. of tin apiece in 1941 models but this has been reduced in the 1942 cars through use of high lead babbits in engine bearings and more lead in solder. Automotive companies consumed 11.4 per cent of U. S. tin needs in 1939, or 10,000 tons. Fifty-six per cent of the world's tin output comes from British Malaya and the Dutch East Indies, but there are other sources of supply in Bolivia and South Africa and a new tin smelter is being built in Texas. Molybdenum has proved an adequate substitute in alloy steels for tungsten, whose source in China is threatened by Japanese action against the Burma road. Only 2 per cent of the world's manganese, another alloy material comes from the Philippines. Substitutes also have been developed in place of tung oil.

U. S. automotive exports to Japan have dwindled continually since 1937, when a 70 per cent tariff was placed upon complete vehicles. The Japanese market was virtually closed to U. S. vehicle imports in 1940 and the assembly plants of Ford at Yokohama and GM at Osaka have been chiefly producing spare parts and rebuilding engines. Japan has not released automobile production figures since 1937 but it is estimated that approximately 27,000 vehicles were produced in the year ending last April. However, only 7000 of these were for private use, the rest going for military purposes. Japanese production has been further hampered in recent months by shortages of iron and steel and lack of skilled labor. Current output is reported to be restricted to "special vehicles" for the army and a few units for export, and is only about one-third of 1940 production.

Restrictions on gasoline and a shortage of tires have curtailed use of motor vehicles in Japan in the last year. It is estimated that only 100,000 motor cars, exclusive of military vehicles, are in use in the Japanese Empire, compared to 175,000 in 1938. This is a ratio of one vehicle to 660 persons compared to one for every four persons in the U. S.

60 Tons of Power

Roaring its defiance, the Army's new 60-ton monster tank proved its power in a grueling test witnessed by War Department officials at the Baldwin Locomotive Works, Eddystone, Pa. The tank, known as T.1-E1 (frequently referred to as the M1), is equipped with three machine guns and one large and one small cannon. A 500 per cent improvement in gunnery over similar land battleships of foreign make is claimed by its producer. Fifty such tanks have been ordered at a total cost of $5,689,725, or about $114,000 each. The first one, however cost nearly $500,000 because of tooling-up and experimental costs. A photograph showing the tank appears on page 17.

Borg-Warner Buys Stover Machinery

Borg-Warner Corp. has announced the purchase of all machinery of the Stover Mfg. & Engine Co., Freeport, Ill., except foundry equipment. The machinery will be moved to another Borg-Warner plant for use in defense work.

Buy Defense Bonds

THE SECRETARY OF THE TREASURY
WASHINGTON

November 25, 1941

Dear Mr. Musselman:

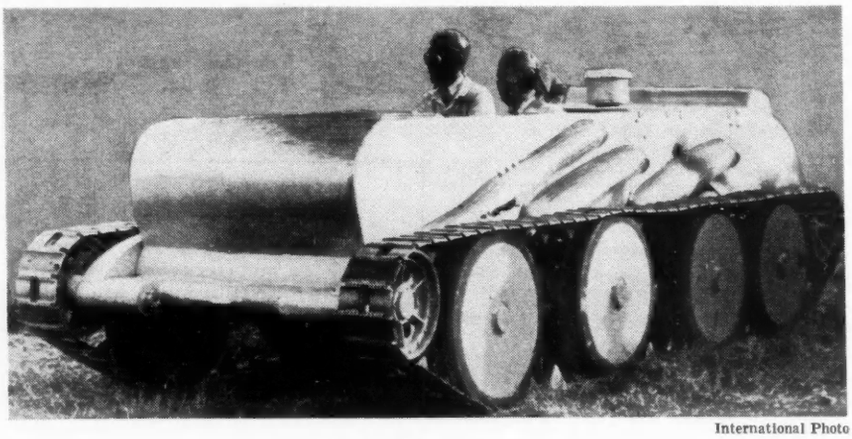
I have read with much interest your letter of November 12th and the accompanying copies of your communications to member publishers of the Associated Business Papers.

In recommending that the business press give continuing publicity to Defense Bonds and Stamps, your committee has made an important contribution to the National Defense Savings program. I should like to express my personal thanks to you and your committee members for this splendid assistance.

The Defense Savings program will have a far-reaching effect upon every American. Certainly it must be given serious and interested consideration by industry and commerce throughout the nation. Through the voluntary cooperation of the business press we can provide American business with a full factual background on this subject which has such a significant relation to present and future business activity.

Sincerely,

Mr. C. A. Musselman,
Chairman,
National Defense Committee,
The Associated Business Papers,
369 Lexington Avenue,
New York, New York.



International Photo

Tank Destroyer

Invented by William Bigely of Hoboken, N. J., this "tank destroyer" is being demonstrated at Arlington, Va. When completed, it is alleged, the tank will sport a 75 mm. cannon and will be able to attain a speed of 75 mph. A metal tread tank, it derives its power from a high-powered airplane engine

War Effort Speed-Up Cuts Industry's Idle

New War Contracts Are Contributing Factor; UAW-CIO Executive Committee Declares Against Work Stoppage

Speeding up of war work has prompted the Michigan Unemployment Compensation Commission to revise its estimates of the amount of unemployment in Michigan industries due to automobile curtailment and material shortages through priorities. An October estimate of 120,000 unemployed in Michigan this winter has been reduced to 80,000 jobless and this probably will be further reduced when defense industries increase the number of shifts under the impetus of war-time production. The probable unemployment includes 50,000 for Detroit, 12,000 in Flint, 4000 in Lansing and 3000 in Pontiac. The State's employment compensation fund at $125 million should be ample to take care of this jobless load for a few months. However, Gov. Murray D. VanWagoner has tried unsuccessfully to have the Michigan legislature increase the period of maximum benefits from 18 to 26 weeks.

Placing of new war contracts totaling $109 million within three weeks with Michigan plants and shortening of working hours in others has helped cut the prospective unemployment. However, certain plants still face shutdowns due to priorities. The metal stamping group in the automotive and parts field has appealed to OPM for designation as a "distressed industry" so that these plants may obtain war orders or subcontracts. "Distressed" industries are allowed a 15 per cent differential in bids on war goods.

Despite needs for all-out production, efforts to work plants on a four-shift, 160-hr. week basis have been stalemated by union refusal to waive premiums for Saturday and Sunday work. The UAW-CIO has urged the payment of such premiums on an equalized basis, with all employes working an equal number of week-ends. Union officials maintain that the cost of paying the overtime rates will be "insignificant," probably assuming it will go into the already huge war costs. They also say overtime pay will improve morale and speed up production, inferring that pecuniary incentives must supplement patriotism in war-time.

The executive committee of the UAW-CIO has taken a strong stand against work stoppages in war-time, calling upon its members to "accelerate their efforts in production of those materials necessary to successful prosecution of the war, placing the welfare of the country ahead of everything.

OPM Extends Bright Work Ban

Passenger car manufacturers have been given until Dec. 31 to use up existing stocks of "bright work" in its present form containing chrome, aluminum, nickel or copper. The original order prohibited use of bright work after Dec. 15, except where special permission was granted for bumpers and bumper guard facilities. Its postponement was ordered by OPM Priorities Director Donald M. Nelson upon recommendation of the automotive, transportation and farm branch of the division of civilian supply.

Because they are functional parts for which no substitutes have yet been found, external windshield wiper-arm and blade assemblies, external lock cylinder caps and covers, ventilator window latches and body trim, bright screws are exempt from the order. Bright work parts which were in inventory or in process of manufacture on Oct. 27, the date of issuance of the original order, may continue to be used after Dec. 31 only if they are treated by some practical method such as acid etching and sand blasting so that they forever lose their identity as bright finish.

Producers desiring to take advantage of the modification must file with the Automotive, Transportation and Farm Equipment Branch before Dec. 31 a statement of Oct. 27 inventories of "bright work" and state what steps they intend to take to comply with permanent removal of bright finish. Proof of compliance must be furnished upon request of the branch.

John J. Coapman

John J. Coapman, 53, died Nov. 23 at his home in Detroit. He was at one time chief engineer of the Denby Motor Truck Co., and later was associated with the Russel Motor Axle Co., the Spicer Mfg. Co., the Motor Wheel Corp., Evans Products Co. and General Motors Corp.

Passenger Car and Truck Production

(U. S. and Canada)

	October 1941	September 1941	October 1940	TEN MONTHS 1941	TEN MONTHS 1940	Per Cent Change
Passenger Car Production—U. S. and Canada						
Domestic Market—U. S.	286,200	164,016	411,016	3,231,028	2,801,704	+15.3
Foreign Market—U. S.	9,368	3,774	10,198	82,209	87,002	− 5.5
Canada	5,635	2,548	7,056	80,391	87,659	− 8.3
Total	301,203	170,338	428,270	3,393,628	2,976,365	+14.0
Truck Production—U. S. and Canada						
Domestic Market—U. S.	74,305	55,992	59,639	763,902	513,931	+48.6
Foreign Market—U. S.	12,127	10,473	12,370	126,839	95,798	+32.4
Canada	13,725	11,948	14,095	148,182	88,340	+67.7
Total	100,157	78,413	86,104	1,038,923	698,069	+48.8
Total—Domestic Market—U. S.	360,505	220,008	470,655	3,994,930	3,315,635	+20.5
Total—Foreign Market—U. S.	21,495	14,247	22,568	209,048	182,800	+14.4
Total—Canadian	19,360	14,496	21,151	228,573	175,999	+29.9
Total—Cars and Trucks—U. S. and Canada	401,360	248,751	514,374	4,432,551	3,674,434	+20.6

New Ordnance Contracts Keep Assembly Lines Going

Buick Completes New Plant for P & W Engine Production; Many Manufacturers Share in Orders for Component Parts

Buick Motor Division of GM has completed its new airplane engine plant at Melrose Park, Ill., near Chicago, and production of the 14-cylinder, 1200-hp. Pratt & Whitney engines is expected to begin some time next spring. The manufacturing division contains 23 acres of floor space. There are also 46 test cells, a three-story administration building, personnel building, dynamometer building and garage. Chevrolet will build the same type engine at its plant at North Tonawanda, N. Y.

Work on the Buick plant was begun last March 17 and it has been completed less than nine months later, substantially ahead of schedule. Two Buick plants in Flint are being converted for manufacture of 50 per cent of the parts and subassemblies going into the engine. Total cost of the plant and equipment at both Melrose Park and Flint is $41 million, while Buick has an initial order for $129 million for the engines.

Oldsmobile Division of GM has received new orders for armor-piercing projectiles and for 75-mm. semi-automatic guns for installation in medium tanks, such as Chrysler is producing. The government has allotted $8 million for machines to produce the 75 mm. guns, and this will be installed in six buildings of the Olds Motor Works at Lansing, covering 200,000 sq. ft. Plant rearrangement is now under way and production is expected to begin in the late spring. Oldsmobile will do extensive subcontracting, manufacturing only three of the 70 gun parts. These are the barrel, breech ring and breech block. Many of the forgings will be produced by other Lansing firms. Initial orders for the guns total $9,396,300.

A $35,705,287 order for 75-mm. armor-piercing shot for use in tank warfare is being split among three GM plants, with Oldsmobile's share being $14,282,115. Chevrolet Motor Division at Flint also has received a $14,282,115 order, while Chevrolet Gear & Axle Division in Detroit will produce shot valued at $7,141,057. Oldsmobile and Motor Wheel Corp. in Lansing will produce 75-mm. semi-armor piercing projectiles. Motor Wheel has an order for $1,505,000 for 400,000 projectiles, while Oldsmobile's order totals $3,105,000. Oldsmobile already is producing 20-mm. Hispano-Suiza aircraft cannon and 75- and 105-mm. shells. Olds is expected to employ 8000 workers on all its defense projects when full production is reached.

Continental Motors Corp. has been awarded an order for $5,087,284 for 7-cylinder 225-hp. radial engines for installation in light tanks and training planes. These engines will be produced at the Muskegon plant, which now employs 3600 men on a three-shift, seven-day basis. Employment at the newly renovated Detroit plant, where 450-hp. Wright Whirlwind engines are being made for medium tanks and training planes, totals 2600 workers. The company's backlog stands at $85,000,000.

In line with the promised Army truck orders to keek Michigan assembly lines operating, Yellow Truck & Coach Mfg. Co. has been awarded a $6,717,424 contract, and Federal Motor Truck Co. has received one for $5,641,420 for Air Corps truck tractors. Other military vehicle orders include $12,730,224 to the Heil Co. for Air Corps oil servicing trucks and trailers and trailer converter dollies; $1,996,860 to Biederman Motors Corp. for truck-tractors; $1,049,075 to International Harvester Corp. for 2½-ton trucks and tractors; $989,400 to Autocar Co. for half-trac truck parts; $1,759,065 to Trailer Co. of America for semitrailers; $453,360 to Nash-Kelvinator Corp. for 2-wheel trailers; $827,049 to Ward-LaFrance Truck Corp. for trucks; $359,049 to Mack Mfg. Corp. for truck parts; and $113,460 to Ford Motor Co. for five-passenger cars.

Canadian Government Limits Truck Production

Hon. C. D. Howe, Canadian Minister of Munitions and Supply, has announced regulations calling for a drastic reduction in 1942 output of light trucks and a limit on the manufacture of transports and buses. The order provides for the licensing on Jan. 1 of all truck manufacturers. Trucks are divided into two classes—those under 10,000 lb. gross rating, and those exceeding that rating. Of the smaller trucks only one-half the quantity produced in 1941 may be built next year. Of the larger trucks, which include furniture vans, transports, and buses, no more than the present year's output will be permitted.

Hart O. Berg

Hart O. Berg, engineer, who sponsored the first flights of the Wright Brothers abroad, died on Dec. 9 after a long illness. He was formerly chief engineer of the Clement-Bayard interests in France, and built at Paris the world's first large automobile factory. He also built in this country a plant which produced a four-cylinder car bearing his name. From the end of the first World War until his death Mr. Berg devoted his time to the development of facilities for the extraction of magnesium.

Vickers Gets "E" Award

Vickers, Inc., Detroit subsidiary of the Sperry Corp., has been awarded the Navy "E" for excellence in recognition of outstanding national defense production. The firm has $28,000,000 in war orders and produces hydraulic gunnery controls for the Navy.

Connecting Rod Assemblies

The first connecting-rod assemblies to be produced at the Detroit plant of the Graham-Paige Motor Corp. are shown being inspected as they come off the line. Those witnessing the inspection are, from left to right, George Petersen, factory manager for Graham; E. R. Harrell, vice-pres. in charge of production; Dennis L. Luther, inspector in charge for the U. S. Army; C. C. Poehlman, inspector; Frank Hoffman, chief inspector for Wright Aeronautical Corp.

International Photo

Modified M-3

This side view of the new M-3A1 shows how it differs from the M-3. Soon to be turned over to the Army Ordance Dept., the tank features a cast-steel top hull with rounded corners which will deflect shells and bullets better than flat surfaces. Casting increases speed of assembly and lessens machining.

Steel Plate Initiates Allocation Program

War Settles Question as to Who Gets Metal First; OPM Inclined to Overlook Minor Issues for Main Task

By W. C. Hirsch

Outbreak of hostilities in the Pacific and formalization of the state of war, have multiplied the problems of metal producers and consumers. Concern over future receipts of metals, such as tin and tungsten, for much of which importers rely upon transportation through the sea lanes, in which the risk of attack on cargo vessels is thought to have sharply increased, has perhaps grown deeper, although stocks on hand and fresh sources of supply are rather reassuring.

Topping anxiety over adequacy in the supply of metals and ores is speculation as to what effect war will have on the defense authorities' program and procedure. Noticeable already is a growing determination on the part of defense officials as well as of manufacturers engaged on Government contracts to get on with the job of supplying the Army and Navy with what they need, and no longer to permit the ironing out of minor points at issue to detract attention from the main task.

OPM officials have their fingers crossed in the hope that the allocation system, which got under way early in December with steel plates being the first product to come under its provisions, will work out satisfactorily. The system gives them full control over rolling mill schedules, making it possible for the most important defense needs to be satisfied first and others graduated in the order of their importance. The responsibility for determining whether an order for steel plates for Army tanks should take precedence over one for lease-lend customers now rests with OPM and steel manufacturers are not exactly unhappy over this. Whether or not previous estimates as to what tonnages of steel will be available for civilian requirements in 1942 will have to be materially revised because of the coming of an actual state of war will depend upon future developments, but it is generally expected in steel circles that pressure for speeding up deliveries of defense material in the immediate months ahead will be more intensive, and that civilian needs can hardly come in for more favorable treatment during the first half of 1942. Last fall it looked as though defense needs would absorb about two-thirds of the country's steel bar output. Now 90 per cent would come nearer to an accurate estimate of current defense requirements.

OPM hearings on possibilities for increasing copper production are expected to result in better knowledge as to the extent of the shortage of the metal and the most efficient way of overcoming it. Suggestions for a further stepping-up in prices to be paid to marginal producers are considered by many as promising but little in the way of added output, and the lifting of the price paid to low cost producers would just be an added drain on the Treasury and would yield no compensating benefit.

Estimates of tin stocks, held by the Government, dealers and consumers are well in excess of 100,000 tons. Together with what tin is afloat to the United States and what is contained in ores stored here for future smelting operations, not much less than 150,000 tons will be available, and even though consumption should run much higher than it ever did, there might still be enough tin for a year's needs.

Whether silver, as reported, is being used in place of nickel in the trim of a few automobiles, is doubted in the metal market where it is pointed out that the white metal's tendency to tarnish may be more of an obstacle than its price.

High-Power Blowers for Engine Cooling

In order to dissipate heat generated during airplane engine tests at Wright Field, Dayton, Ohio, two large blowers, powered by General Electric 2000-hp. motors, and capable of absorbing 20,000,000 B.t.u. per hr., have been installed. These blowers, installed below the engines, will pull air from outside over the test stands and through an opening in the floor into a concrete tunnel, finally discharging it out-of-doors. The required air pressure will be maintained in each test by controllers which will vary the speed of the motors.

Oldsmobile Gets 75 mm. Gun Order

Receipt of government authorization to proceed with the manufacture of 75 mm. guns for the Army Ordnance Department, was announced by the Oldsmobile Division of General Motors Corp. An investment of approximately $8 million will be allotted for machines and machine tools for the new project. The 75 mm. semi-automatic gun is for use in medium size army tanks.

Extensive sub-contracting policies will be followed by Oldsmobile production of the 75 mm. gun. The three principal parts—the barrel or tube, breech ring and breech block will be manufactured at the Olds plant. The other 67 parts will be sub-contracted to outside companies with as many of the forgings as possible going to local firms.

P&W Aircraft Engine Deliveries on Increase

November shipments of airplane engines by the Pratt & Whitney Aircraft division of United Aircraft Corp. totalled more than two million horsepower sufficient horsepower for approximately 850 twin-engine bombers of the Lockheed Hudson or Martin Maryland types.

At its present rate, Pratt & Whitney claims it will produce during the next four months more horsepower than America produced, with the aid of seven automobile manufacturers, during the First World War. Furthermore it will be more than twice the November, 1940 figure.

War Forces Further Slash in Auto Production

61.3 Per Cent Cut Becomes Effective December 15; January Output Cut 75.5 Per Cent; Shortages Loom

Effective December 15, December passenger car production was cut by the OPM Division of Civilian Supply 61.3 per cent below December, 1940, production. January, 1942 production was cut 75.5 per cent below January, 1941, figures.

This means only 153,636 cars may be produced in December, 1941, and 102,424 may be produced during January, 1942.

Manufacturers of light trucks of less than 1½ tons will be cut by 6042 trucks from the quota of 24,169 established for Dec. 1, 1941, and output will be reduced by 12,084 in January.

February passenger car allotments announced November 19 are being revoked pending the outcome of the study. The quota for February, 1942, was fixed at 174,122 cars, a reduction of 56.1 per cent below February, 1941, output. No plan for February production of light trucks has been announced.

All producers will be permitted to adjust their schedules between December 15 and January 31 in any way so that the over-all curtailment will be worked out effectively from the viewpoint of both management and labor. The division said that methods of working out the adjustment will be left to representatives of management and labor.

In announcing the figures, Leon Henderson, head of the Division, said that there is no guarantee that sufficient materials will be available to manufacturers to achieve this production.

G. E. Erects Supercharger Plant

The General Electric Co. has started construction of a $25 million factory at Fort Wayne, Ind., for the manufacture of turbo-superchargers. At present the company is manufacturing the turbo-supercharger, a vital part of high-flying airplanes, at Lynn, Mass. A $5 million factory for similar manufacture has recently been completed at Everett, Mass.

MEN . . . . . .

Joseph A. Sullivan, formerly assistant publicity manager of Chicago Pneumatic Tool Co., has been promoted to advertising manager.

T. I. Phillips, assistant to the president, has been elected a vice-president of Westinghouse Electric & Mfg. Co.

J. M. Chapple, recently with the Detroit office of Lincoln Electric Co., will be in charge of their new office in Jacksonville, Fla. He was formerly managing director of The Lincoln Electric Co. (Australia), Pty., Ltd., at Alexandria.

Harry D. Bubb has been promoted from chief engineer of Thompson Products Co.'s Cleveland plant to director of engineering for both the Cleveland plant and Thompson Aircraft Products Co.

Sidney J. Black, vice-president of Asbestos Mfg. Co., was elected a director, filling the post formerly held by James M. Simpson.

William S. Knudsen, director of the Office of Production Management in Washington, was awarded the Vermilye Medal by The Franklin Institute, Philadelphia, for "invaluable service to his country in the administration of unprecedented production of national defense".

A. A. Gustafson, formerly safety engineer with the U. S. Federal Government, has been appointed director of personnel and safety of The Buda Co.

James D. Mooney, vice-president and a director of General Motors, has been ordered into active service of the United States Navy. Mr. Mooney has been a Lieutenant Commander in the U. S. Naval Reserve since 1937. Beginning Jan. 1, he will head up the Production Engineering Section of the Bureau of Aeronautics, U. S. Navy.

Irving Keough, John Koop, Michael Bruno and **Harry J. Kurz** have been appointed sectional supervisors of the reorganized activities of the Republic Aviation Corp. for the production of the P-47 Thunderbolt.

L. C. McAnly, formerly factory manager of the Rockwood Mfg. Co., Indianapolis, has been appointed works manager of the Fruehauf Trailer Co.

Paul W. Rhame, works manager, and **Charles W. Crick,** assistant to the general manager, have been named as executive assistants to general manager George Mann, Jr., of the AC Spark Plug Division of GM. Rhame will head machine gun production and Crick will be in charge of automotive products. **Joseph Anderson,** assistant works manager, will become works manager in charge of both defense and automotive production. **Miles Hanson,** superintendent, has been named assistant works manager in the machine gun department and **Lee Sherrod,** superintendent, will be assistant works manager for automotive and other civilian products.

Ray Chamberlain, manager of merchandising for the Packard Motor Car Co., has resigned to take over the position of executive vice-president of the National Automobile Dealers Association. He will direct the activities of the association from the new Washington headquarters. Chamberlain had been with Packard since 1916.

Three metallurgists from the automotive industry have been appointed members of an eight-man senior technical advisory committee by OPM on the development of new alloy steels for military and naval use. They are: **A. L. Boegehold,** chief of the metallurgical research department of General Motors Corp.; **R. H. McCarroll,** chief metallurgist of the Ford Motor Co., and **E. D. Stilwell,** metallurgist with the Chrysler Corp.

F. A. Alter has been placed in charge of civilian truck and commercial car sales for the Ford Motor Co., while **R. E. Burns** will direct military vehicle sales.

Wilcox-Rich Division of Eaton Mfg. Co. has announced the following changes in its Saginaw plants: **Herman P. Hess,** plant superintendent, becomes general superintendent; **Lee C. Case,** purchasing agent, will be production manager; **Carl E. Dilts,** engineering and drafting supervisor, becomes chief engineer, and **John Decker,** assistant chief inspector of Plant 1, becomes chief inspector of Plant 2.

Anthony F. Fuerth, formerly with the Ford motor Co. of Canada, has been named personnel director of the Chrysler Corp. of Canada.

(Turn to page 48, please)

Wide World Photo

Triple-Deck Auto Barge

Designed to carry 150 autos down the Mississippi, this new barge, is an answer to the problem of finding more rail capacity for defense materials. Ordinary barges have only a fraction of the capacity of this new design. Ingeniously made of steel runways that are removable, these barges are unloaded easily at the rate of one per minute by a portable crane at the dock edge. Special hooks which fit around the tires of the cars facilitate the unloading operation.

October New Truck Registrations

	October 1941	September 1941	October 1940	TEN MONTHS 1941	TEN MONTHS 1940	Per Cent Change, 10Months 1941 over 1940	Per Cent of Total Ten Months 1941	Per Cent of Total Ten Months 1940
Chevrolet	13,947	14,004	14,793	187,403	155,207	+ 20.7	33.29	33.20
Ford	7,916	8,291	14,349	151,331	130,859	+ 15.6	26.88	27.99
International	6,550	8,125	7,615	82,701	66,048	+ 25.2	14.69	14.13
Dodge	5,102	4,936	3,925	54,351	46,153	+ 17.8	9.65	9.87
G. M. C.	3,573	4,368	3,065	39,959	32,232	+ 23.9	7.10	6.89
Mack	1,031	864	842	8,507	6,348	+ 34.2	1.51	1.36
White	807	731	579	8,146	5,308	+ 53.7	1.45	1.14
Plymouth	199	287	584	7,555	8,134	- 7.1	1.34	1.74
Diamond T	475	520	601	5,363	5,490	- 2.3	.95	1.17
Studebaker	486	554	108	4,433	1,039	+326.7	.79	.22
Autocar	221	217	429	2,193	1,639	+ 33.8	.39	.35
Divco	181	145	126	2,016	1,413	+ 42.7	.36	.30
Brockway	213	203	247	1,989	1,366	+ 45.6	.35	.29
Willys-Americar	130	159	172	1,755	2,063	- 14.9	.31	.44
Federal	150	133	137	1,350	1,358	- .6	.25	.29
Reo	163	132	103	1,335	427	+212.6	.24	.09
Hudson	31	35	49	668	623	+ 7.2	.12	.13
Sterling	25	20	29	358	276	+ 29.7	.06	.06
F. W. D.	16	41	26	238	223	+ 6.7	.04	.05
Bantam	.....	2	9	40	327	-177.7	.02	.07
Miscellaneous	136	125	121	1,201	988	- 41.8	.21	.22
Total	41,352	43,892	47,909	562,892	467,521	+ 20.4	100.00	100.00

Tire and Tube Output Halted

OPM's stoppage order on production of tires and tubes along with other rubber products for civilian use was occasioned by the cessation of imports of rubber from the Far East. Warning was given the public not to engage in unnecessary buying. At the same time, OPM officials gave assurance that there are ample supplies available for replacement of worn out tires and tubes. It was also stated that tires and tubes may be produced for new cars and that there will be no restrictions against the use of camelback in retreading tires.

At a meeting of rubber processors, including the four major tire and tube manufacturers, OPM civilian supply officials outlined a temporary plan of curtailment that will be recommended for Supply, Priorities and Allocations Board approval immediately.

[The OPM program would suspend the production of passenger automobile tires and approximately 30,000 other non-essential products in which rubber is used, for about two weeks, according to the Associated Press.]

Rubber processing under the temporary order may be continued for the following purposes:

1. Orders having A-3 and higher priority ratings; this covers all arms orders.
2. Production of camelback rubber on a reduced scale.
3. Production of tires and tubes for heavy trucks.
4. Production for industrial equipment, medical and surgical supplies, heels and soles for shoes, plumbing supplies and insulating wire.

Tire Dealers Meet

Sales and advertising plans for 1942 were discussed by dealers of the General Tire and Rubber Co. in Detroit early this month.

OPM Reorganizes Contract Distribution

Under a reorganization plan for the Division of Contract Distribution of OPM, the positions of coordinator and district manager have been abolished and an advisory committee and a State director have replaced them. Clarence W. Avery, president of Murray Corp. of America and former coordinator for the Detroit district, becomes chairman of the Michigan advisory committee and Warren H. Clarke, former Detroit district manager, becomes Michigan State director. Other members of the advisory committee besides Avery are Irving B. Babcock, president and general manager of Yellow Truck & Coach Mfg. Co., Pontiac; Monroe Shakespeare, president of the Shakespeare Co., Kalamazoo; Frank W. Steere, assistant chief of the Detroit Ordnance District, U. S. Army, and Harry M. Taliaferro, president of the American Seating Co., Grand Rapids.

Avery and Babcock will represent large business concerns on the committee. Shakespeare, president of the National Small Business Men's Association, and Taliaferro will be the representatives of small business and Steere will sit in for the Army.

Canada to Build Up Reserve Supply of Cork

In order to forestall the possibility of a shortage of cork, the Canadian Department of Munitions and Supply has decided to regulate its importation and distribution. The new cork order, designed to prohibit the hoarding of cork, will limit supplies in the hands of any dealer or processor to his normal requirements for three months. While the bulk of semi-processed cork is procured from the United States, virtually all of the raw material comes from Lisbon. Since no practical substitute for cork is available, the government is planning to build up its reserves.

Canada Limits Color Shades

J. D. Lorimer, Chemical Controller of the Canadian Department of Munitions and Supply, has issued an order reducing from 600 to 15 the number of shades in which bakelite can be made. The new order results from the increasing demand for bakelite resin which is used in the manufacture of shells.

December Production

(*Continued from page* 42)

of October, according to R. L. Polk & Co. October new passenger car registrations in turn were 43 per cent below the same month a year ago, totaling 165,485 units. New truck registrations in October were down 14 per cent from 1940 to 41,352 units, but larger than any other October in the last 10 years. Field stocks of new passenger cars were estimated at 238,900 units as of Nov. 1, rising 74 per cent during October. Dealers were not unduly worried about government proposals to put price ceilings on new passenger cars, such prices having risen 9½ per cent since August, reflecting the higher 1942 model costs. However, they were alarmed by government threats to limit output in the 1943 model season to 25 per cent of the 1942 quotas, which would embrace about 500,000 units.

MEN

(*Continued from page* 47)

Charles T. Fisher, president of Fisher & Co., has been appointed a lay trustee of Notre Dame University, succeeding his brother, the late Fred Fisher.

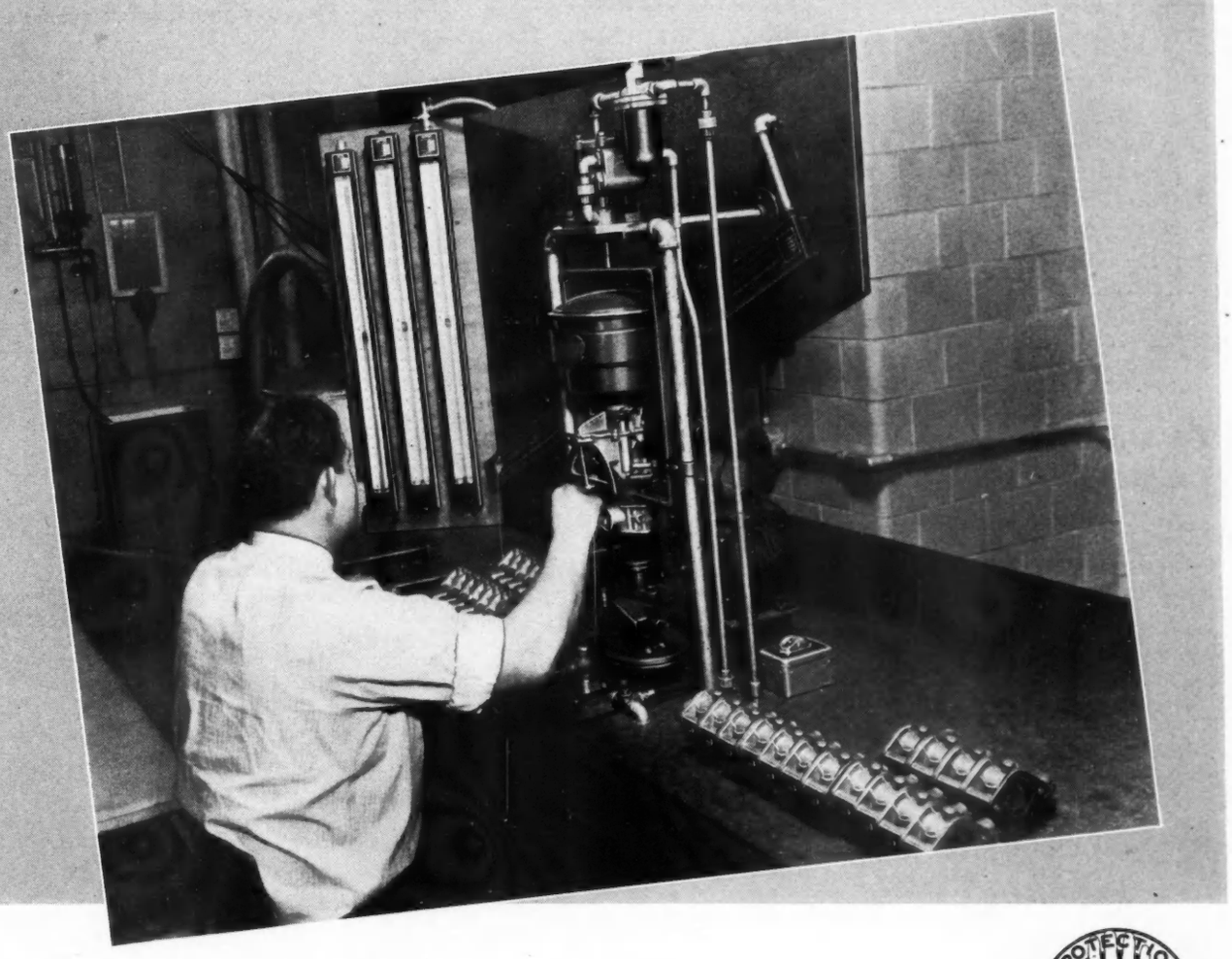
A. A. Bull, formerly president of the Handy Governor Co., has been elected president of Michigan Wire Cloth Co., Detroit. Other new officers are **Harold A. Wilson,** vice-president and general manager, and **S. W. Farnsworth,** of New York, treasurer.

H. J. Klinger, general manager of the Pontiac Motor Division, has announced several changes in key positions in the manufacturing department. **P. H. MacGregor,** for several years general manufacturing manager of Pontiac's automobile plants, becomes assistant to the general manager in charge of production for both automotive and defense activities. **Stanley Ostrander,** formerly general plant superintendent, has been appointed plant manager in charge of automotive production. **Robert H. Ahler** continues as manager of defense production. **William Vann** is advanced from chief inspector to assistant plant manager, succeeding Ostrander, while **O. F. Marshall** has been promoted from general supervisor to chief inspector; **Ray Powers** has been made assistant chief inspector. **F. J. McLaughlin,** former Pontiac purchasing agent, has been appointed assistant to the general manager in charge of all supplies. **Fred Gordon** has been made automotive purchasing agent, with **Martin Rummel** as assistant. **L. Rodford, Jr.,** continues as defense purchasing agent under McLaughlin, with **H. F. Decker** as assistant.

R. B. Jenkins of the Briggs Mfg. Co., Detroit, has been appointed as a member of OPM's Plumbing and Heating Advisory Commission.

Armand T. Chandonnet, for the last three years manager and treasurer of the Elmira Foundry Co., Inc., of Elmira, N. Y., has been appointed coordinator of aircraft turret manufacture in all G-E plants. **N. Harold Boardman** will succeed Mr. Chandonnet on January 1, 1942.

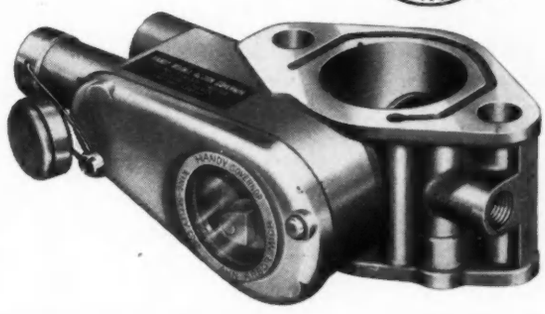
KING-SEELEY ADOPTS THE FLOW BENCH FOR FINAL INSPECTION OF HANDY GOVERNORS



THE Flow Bench is a practical device for simulating the conditions of engine operation. By means of this device, engine manifold and carburetor Venturi vacuums for any selected speed can be accurately reproduced. This type of device has been used in the past as an inspection tool for carburetors, and King-Seeley Corporation has now adopted it for the final inspection of Handy Vari-Speed Governors.

The final result of this inspection is a product which has been accurately checked for performance, under conditions which are identical to those under which it will have to operate. Furthermore, not only is the no-load speed set on this Flow Bench, but operation is checked throughout the governing range. In addition, the surge, cheat and operation of the distributor vacuum valve are also checked.

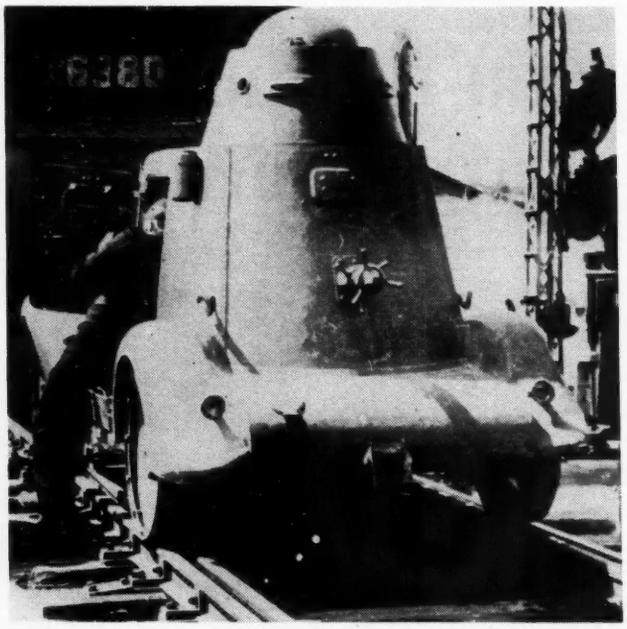
This method of inspection assures the effective and accurate functioning of Handy Governors when they are finally put into service.



KING-SEELEY CORPORATION • Ann Arbor, Mich.

HANDY *Visible Action* GOVERNORS

World's Largest Manufacturers of Automotive Governors



Armored Railcar

This armored vehicle is being used by the Russians to protect trains hauling supplies along the Russo - German front. It is essentially an automobile chassis fitted with flanged wheels and an armored superstructure.

OPA Studies Price Rise for Rubber "Camelback"

Reasonableness of increases ranging from 12 to 20 per cent in the price for rubber "camelback," used to retread worn automobile tires, is under investigation by the OPA and producers are being requested not to advance prices further pending completion of the study.

Price Administrator Leon Henderson pointed out the probability that tire retreading volume will expand substantially under the rubber conservation program and that, in consequence, "public dependence upon camelback during the emergency will be very great."

The three major grades of camelback have increased in price by 12, 15 and 20 per cent, respectively.

Tide Water to Market Hood Tires

Tide Water Associated Oil Co. has signed a contract to handle in its Eastern retail outlets the complete line of Hood tires and tubes for passenger cars and motor trucks.

Lighting in Reverse for Sabotage Protection

Westinghouse engineers are suggesting the use of glare as a defense aid to blind would-be intruders to a defense plant. The desired effect would be achieved by installing a row of luminaires, lamps equipped with Fresnel lenses, on posts several feet away from the buildings to be protected, aimed so their light is projected slightly downward away from the buildings. The space between the luminaires and the buildings is virtually in darkness. An intruder approaching the plant sees only these blinding spots of light; guards behind the lights see him clearly.

Production Order on Heavy Trailers Lifted

Limitation Order L-1-a which has restricted the production of heavy truck trailers as well as the manufacture of bodies and cabs for medium motor trucks has been lifted under an order from the OPM Priorities Division issued Dec. 4. The Division of Civilian Supply pointed out that the production restriction contained in Limitation Order L-1-a of truck trailers of five tons or more during the last quarter of 1941 to two-thirds of the output during the first half of 1941 should be lifted because trailers of this type proved the most economical form of commercial highway transportation both as to cost and metals consumed. Production curtailment of bodies and cabs for medium motor trucks was said to be unnecessary since the limitation on medium trucks would govern body and cab manufacture.

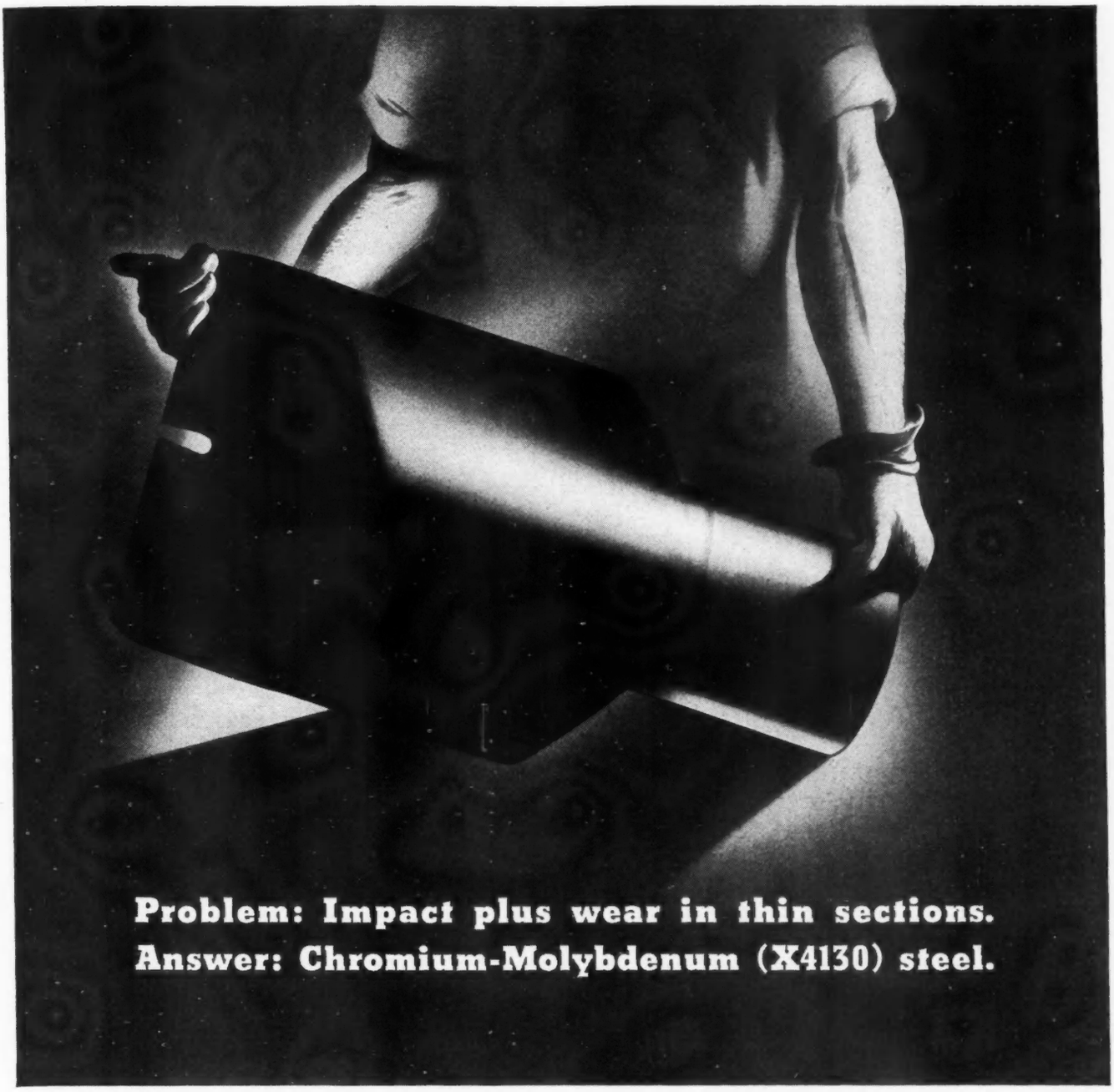
CALENDAR

Conventions and Meetings

NSPA National Defense Conference, Chicago ..... Dec. 11-18
Society of Automotive Engineers, Annual Meeting, Detroit ..... Jan. 12-16
Natl. Automobile Dealers Assoc., Chicago ..... Jan. 19-22
Motor & Equipment Wholesalers Assoc., Atlantic City ..... Feb. 23-28
American Society for Testing Materials, Cleveland ..... March 2-5

October New Passenger Car Registrations

	OCTOBER 1941	SEPT. 1941	OCTOBER 1940	TEN MONTHS 1941	TEN MONTHS 1940	Per Cent Change, 10 Months, 1941 over 1940	Per Cent of Total Ten Months 1941	Per Cent of Total Ten Months 1940	ONE MONTH MODEL YEAR 1941	ONE MONTH MODEL YEAR 1940	ONE MONTH MODEL YEAR Per Cent Change
Chevrolet	40,243	20,236	71,689	809,392	692,522	+ 16.9	23.86	24.91	40,243	71,689	— 43.9
Ford	24,670	22,708	41,761	548,300	441,523	+ 24.2	16.16	15.88	24,670	41,761	— 40.9
Plymouth	21,052	20,526	41,517	415,125	365,020	+ 13.7	12.24	13.13	21,052	41,517	— 49.3
Buick	10,588	5,927	32,283	276,950	238,804	+ 15.9	8.16	8.59	10,588	32,283	— 67.2
Pontiac	12,054	6,521	22,576	258,124	186,855	+ 38.1	7.61	6.72	12,054	22,576	— 46.6
Oldsmobile	7,832	4,129	18,627	207,927	159,629	+ 30.3	6.13	5.74	7,832	18,627	—479.5
Dodge	10,455	10,806	10,273	195,326	163,883	+ 19.2	5.76	5.90	10,455	10,273	+ 1.8
Chrysler	5,912	5,770	6,486	132,008	78,994	+ 67.1	3.89	2.84	5,912	6,486	— 8.8
Studebaker	6,194	5,695	10,113	101,568	85,477	+ 19.4	2.99	3.08	6,194	10,113	— 38.8
De Soto	4,450	4,297	4,820	83,242	58,844	+ 41.5	2.45	2.12	4,450	4,820	— 7.7
Mercury	3,395	2,498	4,759	73,051	65,577	+ 11.4	2.15	2.36	3,395	4,759	— 28.7
Nash	3,398	2,319	2,534	70,990	42,262	+ 67.9	2.09	1.52	3,398	2,534	+ 34.1
Hudson	4,149	5,238	8,044	66,214	67,694	— 2.2	1.95	2.44	4,149	8,044	— 48.4
Packard	6,082	4,860	7,046	60,256	62,303	— 3.3	1.78	2.24	6,082	7,046	— 13.7
Cadillac	2,728	1,210	3,971	53,411	28,656	+ 86.4	1.57	1.03	2,728	3,971	— 31.3
Willys-Americar	1,135	1,395	1,418	20,407	17,990	+ 13.4	.61	.65	1,135	1,418	— 20.0
Lincoln	969	604	1,859	16,417	17,400	— 5.6	.48	.63	969	1,859	— 47.9
Crosley	136	177	48	958	369	+159.6	.04	.01	136	48	+183.3
Graham	12	13	201	531	1,526	—352.0	.02	.05	12	201	—503.0
Bantam	5	16	44	125	745	— 83.2	.....	.03	5	44	—186.3
Miscellaneous	26	348	426	1,909	3,513	— 45.7	.06	.13	26	426	—689.7
Total	165,485	125,293	290,495	3,392,231	2,779,586	+ 22.0	100.00	100.00	165,485	290,495	— 43.1
Chrysler Corp.	41,869	41,399	63,096	825,701	666,741	+ 23.8	24.34	23.99	41,869	63,096	— 33.6
Ford Motors	29,034	25,810	48,379	637,768	524,500	+ 21.6	18.80	18.87	29,034	48,379	— 40.0
General Motors Corp.	73,445	38,023	149,146	1,605,804	1,306,466	+ 22.9	47.34	47.00	73,445	149,146	— 50.8
All Others	21,137	20,061	29,874	322,958	281,879	+ 14.6	9.52	10.14	21,137	29,874	— 29.3



Problem: Impact plus wear in thin sections.
Answer: Chromium-Molybdenum (X4130) steel.

The aircraft use of Chromium-Molybdenum (X4130) steel has established its effectiveness in parts requiring high strength and toughness in light sections.

The steel is meeting similar requirements in drag-bit blades. They are normalized from 1650 F., oil quenched from 1550 F., and tempered at 900 F.

The allowable high temper, with a retained hardness of 363 B.H.N., provides good wear resistance in addition to the required impact and tensile strength.

Technical details concerning X4130 steel and its applications will be found in "Section 2—Chromium-Molybdenum Steels" in our book, "Molybdenum in Steel". A copy of this informative technical book will gladly be sent you without charge.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • CALCIUM MOLYBDATE

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY

Bearings—Rear Axle, King Pin and Wheel

Line Number	PASSENGER CAR MAKE AND MODEL	REAR AXLE			KING PIN			WHEELS			Line Number
		PINION SHAFT							FRONT		
		Front	Rear	Differential	Upper	Lower	Thrust	Rear	Inner	Outer	
1	Buick-Special....42-40A	ND 5607	Hy C-1507	Hy KA-11445-Z	Bu 1266949 (GM)	Bu 1266949 (GM)	H-N 148393 or 134630	Hy 1502	ND 909062	ND 909025	1
2	Buick-Ex. Spec....42-40B	ND 5607	Hy C-1507	Hy KA-11445--Z	Bu 1266949 (GM)	Bu 1266949 (GM)	H-N 148393 or 134630	Hy 1502	ND 909062	ND 909025	2
3	Buick-Super....42-50	ND 5607	Hy C-1507	Hy KA-11445-Z	Bu 1266949 (GM)	Bu 1266949 (GM)	H-N 148393 or 134630	Hy 1502	ND 909062	ND 909025	3
4	Buick-Century....42-60	ND 5607	Hy C-1507	Hy KA-11445-Z	Bu 1266949 (GM)	Bu 1266949 (GM)	H-N 148393 or 134630	Hy 1502	ND 909062	ND 909025	4
5	Buick-Roadmaster....42-70	ND 5607	Hy C-1507	Hy KA-11445-Z	Bu 1266949 (GM)	Bu 1266949 (GM)	H-N 148393 or 134630	Hy 1502	ND 909062	ND 909025	5
6	Buick-Limited....42-90	ND 5607	Hy C-1507	Hy KA-11630-Z	Bu 1319729 (GM)	Bu 1319729 (GM)	Nice 1289123	Hy 1508	ND 909028	ND 909027	6
7	Cadillac....61, 62, 63, 60S	Tim 3880-3820	Tim 3779-3732	H-T (g)	BSb $\frac{5}{8}$x1$\frac{1}{16}$x1$\frac{1}{4}$	BSb $\frac{5}{8}$x1$\frac{1}{16}$x1$\frac{1}{4}$	BB 1438440 (GM)	ND 88128	ND 909062	ND 909062	7
8	Cadillac....67, 75	Tim 3880-3820	Tim 49580-49520	Tim (f)	BSb $\frac{5}{8}$x1$\frac{1}{16}$x1$\frac{1}{4}$	BSb $\frac{5}{8}$x1$\frac{1}{16}$x1$\frac{1}{4}$	BB 1438440 (GM)	ND 88128	ND 909062	ND 909062	8
9	Chevrolet....	ND 5306	Hy C-1506	Hy KA-11360-Z	Bz $\frac{7}{8}$x1$\frac{3}{4}$x1$\frac{5}{16}$	Bz $\frac{7}{8}$x1$\frac{3}{4}$x1$\frac{5}{16}$	ND $\frac{3}{8}$x$\frac{5}{16}$	Hy C-1500	ND 909052	ND 909001	9
10	Chrysler-Roy. & Win....C-34	Tim 31590-31520	Tim 31593-31520	Tim 25580-25520	Tor NB-15	Lbs .797x.925x1.200	BB .803x1.563x.563	Tim 25877-25821	Tim 14123-14276	Tim 09074-09194	10
11	Chrysler-Sar. & N.Y....C-36	Tim 3476-3420	Tim 3875-3820	Tim 25580-25520	Tor NB-19	Lbs. .938x1.184x1.406	BB .944x1.750x.625	Tim 2780-2736	Tim 2585-2523	Tim 1755-1729	11
12	Chrysler-Crown Imp....C-37	Tim 3878-3820	Tim 46176-46368	Tim 28580-28521	Tor NB-19	Lbs. .938x1.184x1.406	BB .944x1.750x.625	Tim 26880-26822	Tim 2877-2820	Tim 1280-1220	12
13	Crosley....'42	Tim 1380-1328	Tim 1380-1328	Tim 14138-14277	Bz	Bz	....	Tim 15575T-15520	Tim 1380-1328	Tim 17580-17520	13
14	De Soto-DeL. & Cust....S-10	B-T 31590-31520	B-T 31593-31520	B-T 25580-25520	Tor NB-15	Lbs. .797x.925x1.200	BB .803x1.563x.563	B-T 25877-25821	B-T 14123-14276	B-T 09074-09194	14
15	Dodge-DeL. & Cust....D-22	B-T 31590-31520	B-T 31593-31520	B-T 25580-25520	Lbs. .797x.925x1.200	Lbs. .797x.925x1.200	BB .803x1.563x.563	B-T 25877-25821	B-T 14123-14276	B-T 09074-09194	15
16	Ford-Six....	Tim 799056-799055(2)	Rb	Tim 799115-799116	....	....	TRb	Rb	Tim 799072-799076	Tim 799061-799065	16
17	Ford-Eight....	Tim 799056-799055(2)	Rb	Tim 799115-799116	....	....	TRb	Rb	Tim 799072-799076	Tim 799061-799065	17
18	Hudson-Six & DeL....20	Tim 02876-02820	Tim 31594-31520	B-T 24780-24720	....	Bu	14 steel balls	Tim 25877T-25820	B-T 15118-15250	Tim 09078-09195	18
19	Hudson-Super. & Com. 6....21, 22	Tim 02876-02820	Tim 31594-31520	B-T 24780-24720	....	Bu	14 steel balls	Tim 25877T-25820	B-T 15118-15250	Tim 09078-09195	19
20	Hudson-Com. 8....24, 25	Tim 02876-02820	Tim 31594-31520	B-T 24780-24720	....	Bu	14 steel balls	Tim 25877T-25820	B-T 15118-15250	Tim 09078-09195	20
21	Hudson-Com. Cust. 8....27	Tim 02876-02820	Tim 31594-31520	B-T 24780-24720	....	Bu	14 steel balls	Tim 25877T-25820	B-T 15118-15250	Tim 09078-09195	21
22	Lincoln-Zeph. & Cont....	Tim 799126-799127	Tim 799124-799125	Tim 799115-799116	....	....	....	....	Tim 799072-799076	Tim 799061-799065	22
23	Lincoln-Custom....	Tim 799126-799127	Tim 799124-799125	Tim 799115-799116	....	....	....	....	Tim 799072-799076	Tim 799061-799065	23
24	Mercury....	Tim 799056-799055	Rh	Tim 799115-799116	....	....	TRb	Rb	Tim 799072-799076	Tim 799061-799065	24
25	Nash-Ambassador 600....42-40	Tim 02474-02420	Tim 23790-23720	Tim 24780-24721	Rb	Rb	BB	Tim 14582T-14525	Tim 15580-15520	Tim 17580-17520	25
26	Nash-Ambassador 6....42-60	Tim 31590-31520	Tim 3877-3820	Tim 25580-25523	Bu	Bu	BB	Tim 2798T-2729	Tim 14138A-14276	Tim 12580-12520	26
27	Nash-Ambassador 8....42-80	Tim 31590-31520	Tim 3877-3820	Tim 25580-25523	Bu	Bu	BB	Tim 2798T-2729	Tim 14138A-14276	Tim 12580-12520	27
28	Oldsmobile-Special Six....66	ND 5306	Hy C-1509	Hy A-165275-Z	BSb 231905 (GM)	BSb 231905 (GM)	ND 230679 (GM)	ND 88128	ND 909052	ND 909001	28
29	Oldsmobile-Dynamic Six....76	ND 5306	Hy C-1509	Hy A-165275-Z	BSb 231905 (GM)	BSb 231905 (GM)	ND 230679 (GM)	ND 88128	ND 909052	ND 909001	29
30	Oldsmobile-Special 8....68	ND 5306	Hy C-1509	Hy A-165275-Z	BSb 231905 (GM)	BSb 231905 (GM)	ND 230679 (GM)	ND 88128	ND 909052	ND 909001	30
31	Oldsmobile-Dynamic 8....78	ND 5306	Hy C-1509	Hy A-165275-Z	BSb 231905 (GM)	BSb 231905 (GM)	ND 230679 (GM)	ND 88128	ND 909052	ND 909001	31
32	Oldsmobile-Custom 8....98	ND 5306	Hy C-1509	Hy A-165275-Z	BSb 231905 (GM)	BSb 231905 (GM)	ND 230679 (GM)	ND 88128	ND 909052	ND 909001	32
33	Packard-Six....2000-2020	Tim 31590-31520	Tim 3877-3820A	Tim 25580-25520	(e)	.866x1.189x1.187	BB	Tim 25877-25821	Tim 14130-14276	Tim 09074-09194	33
34	Packard-Eight....2001-2021	Tim 3879-3820	Tim 3776A-3735	Tim 2984-2924	(e)	.866x1.189x1.187	BB	Tim 26878-26830	Tim 2585-2523	Tim 1380-1329	34
35	Packard-Sup. 8....2003-23-4-5	Tim 3879-3820	Tim 3776A-3735	Tim 2984-2924	(e)	.866x1.189x1.187	BB	(b)	(c)	(d)	35
36	Packard-Cus. Sup. 8....2006-7-8	Tim 3879-3820	Tim 3776A-3735	Tim 2984-2924	(e)	.866x1.189x1.187	BB	(b)	(c)	(d)	36
37	Plymouth-DeL. & Spec. DL....P-14	Tim 31590-31520	Tim 31593-31520	Tim 25580-25520	Lbs. .797x.925x1.200	Lbs. .797x.925x1.200	BB .803x1.563x.563	Tim 25877-25821	Tim 14125A-14276	Tim 09074-09194	37
38	Pontiac-DeLuxe 6....42-25	ND 5306	Hy C-1509	Hy A-165275-Z	Bz .863x1.054x1.235	Bz .863x1.054x1.235	BB 230679 (GM)	ND 88128	ND 909052	ND 909001	38
39	Pontiac-Stream. 6....42-26	ND 5306	Hy C-1509	Hy A-165275-Z	Bz .863x1.054x1.235	Bz .863x1.054x1.235	BB 230679 (GM)	ND 88128	ND 909052	ND 909001	39
40	Pontiac-DeLuxe 8....42-27	ND 5306	Hy C-1509	Hy A-165275-Z	Bz .863x1.054x1.235	Bz .863x1.054x1.235	BB 230679 (GM)	ND 88128	ND 909052	ND 909001	40
41	Pontiac-Stream. 8....42-28	ND 5306	Hy C-1509	Hy A-165275-Z	Bz .863x1.054x1.235	Bz .863x1.054x1.235	BB 230679 (GM)	ND 88128	ND 909052	ND 909001	41
42	Studebaker Champion 6....4G	Tim 02872-02820	Tim 31593-31520	Tim 24780-24721	Tor B-1816	BBC 1.125x1.250x.750	Nice 5136	Tim 14123T-14276	Tim 15580-15520	Tim 17580-17520	42
43	Studebaker-Commander 6....12A	Tim 02872-02820	Tim 31593-31520	Tim 25577-25523	Tor B-2016	BBC 1.190x1.316x1.250	Nice 5920	Tim 25877-25821	Tim 14125-14274	Tim 09074-09194	43
44	Studebaker-President 8....8C	Tim 02872-02820	Tim 31593-31520	Tim 25577-25523	Tor B-2016	BBC 1.190x1.316x1.250	Nice 5920	Tim 25877-25821	Tim 14125-14274	Tim 09074-09194	44
45	Willys-Americar....442	Tim 02872-02820	Tim 31593-31520	Tim 24780-24721	Tor M-12121	Bu .750x....	Mat	Tim 14123T-14276	Tim 15118-15250	Tim 09074-09194	45

ABBREVIATIONS:

(2)—Two used
(a)—Y-on right hand, Z-on left hand
(b)—Timken 3576-3525 on models 2005 and 2008
Timken 26878-26830 on model 2003
(c)—Tim. 2585-2523 on models 2003-5-8
Tim. 2788-2720 on models 2004-6-7
(d)—Tim. 1380-1329 on models 2003-5-9
Tim. 2687-2620 on models 2004-6-7
(e)—Needle bearing on models 2000-3-6; bushing .866x1.189x1.187 on all others
(f)—25584T-25528 on right hand
28577T-28521 on left hand
(g)—Hyatt A-125298-Y right hand, A-125298-Z left hand
Timken 25584T-25528 right hand, 25584T-25526 left hand
BB—Ball bearing
BBC—Bound Brook Company
BSb—4035-M bronze, steel backed
B-T—Bower Roller Bearing Co. and Timken Roller Bearing Co.
Bu—Bushing
Bz—Bronze bushing
(GM)—General Motors number
H-N—Hoover or Nice
H-T—Hyatt or Timken
Hy—Hyatt Bearings Division
Lbs—Lead bronze on steel
Mat—Matthews Mfg. Co.
Nb—Needle bearing
ND—New Departure Division
Rb—Roller bearing
Tim—Timken Roller Bearing Division
Tor—Torrington Company
TRb—Tapered roller bearing
Note Timken and Bower bearing numbers are shown in the order of first cone and then cup.
Bearing dimensions are in order of inside diameter, outside diameter and width.

Give him the right products...

HE KNOWS HOW TO USE THEM!

He knows that Form-A-Gasket Number 1 is a paste that dries fast and sets hard. That it is used principally for making permanent assemblies and for building up uneven or warped surfaces. That it withstands highest pressure and greatest strain.

He knows that Form-A-Gasket Number 2 is a paste that dries slowly, remains pliable and disassembles very easily. That it is principally used for general assembly work. That it preserves all types of solid gaskets from heaviest copper to thinnest cork.

He knows that Aviation Form-A-Gasket is a liquid that quickly changes to a paste and does not dry nor run when subjected to heat. That it is used on cylinder head gaskets to prevent water seepage, corrosion and head seizure. That it is extensively used on machined surfaces and screw thread connections.

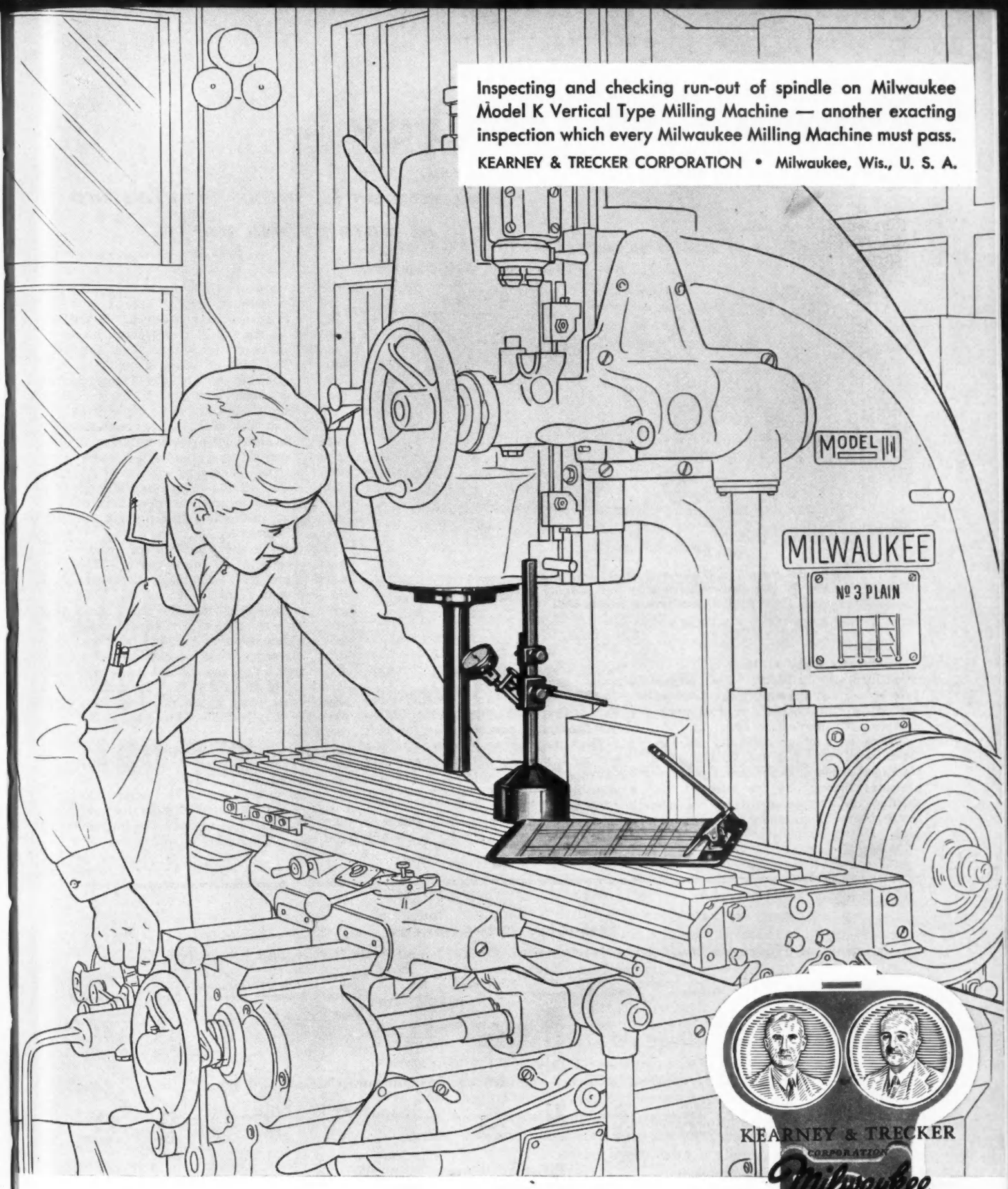
PERMATEX COMPANY, INC., Sheepshead Bay, N. Y., U. S. A.

Bearings—Electrical Units, Clutch, Transmission

Line Number	PASSENGER CAR MAKE AND MODEL	WATER PUMP	STARTER		GENERATOR		CLUTCH		TRANSMISSION					Line Number
		Shaft and Bearing Assembly	Commutator End	Drive End	Commutator End	Drive End	Pilot	Throwout	Drive Shaft Rear	MAIN SHAFT Front Pilot	MAIN SHAFT Rear	Counter Shaft	Reverse Idler	
1	Buick-Special 42-40A	ND 885156	Cl .563x.9687	OB .500x.562x.781	Bu .562x.783x.796	ND 3203	ND 7109	BCA CTL-48	ND 47507	14 rol. 1294780 (GM)	ND 3206	Rol 1302154 (GM)	Bu 1307898	1
2	Buick-Ex. Spec. 42-40B	ND 885156	Cl .563x.9687	OB .500x.562x.781	Bu .562x.783x.796	ND 3203	ND 7109	BCA CTL-48	ND 47507	14 rol. 1294780 (GM)	ND 3206	Rol 1302154 (GM)	Bu 1307898	2
3	Buick-Super 42-50	ND 885156	Cl .563x.9687	OB .500x.562x.781	Bu .562x.783x.796	ND 3203	ND 7109	BCA CTL-48	ND 47507	14 rol. 1294780 (GM)	ND 3206	Rol 1302154 (GM)	Bu 1307898	3
4	Buick-Century 42-60	ND 885156	Cl .563x.9375	OB .563x.625x.750	Bu .562x.783x.796	ND 3203	ND 7109	BCA CTDS-48	ND 47507	14 rol. 1294780 (GM)	ND 43306	Rol 1298445 (GM)	Bu 1321609	4
5	Buick-Roadmaster 42-70	ND 885156	Cl .563x.9375	OB.563x.625x.750	Bu .562x.783x.796	ND 3203	ND 7109	BCA CTDS-48	ND 47507	14 rol. 1294780 (GM)	ND 43306	Rol 1298445 (GM)	Bu 1321609	5
6	Buick-Limited 42-90	ND 885156	Cl .563x.9375	OB .563x.625x.750	Bu .562x.783x.796	ND 3203	ND 7109	BCA CTDS-48	ND 47507	14 rol. 1294780 (GM)	ND 43306	Rol 1298445 (GM)	Bu 1321609	6
7	Cadillac 61, 62, 63, 60S	ND 88016	Cl frame	Bz $\frac{3}{4}$x$\frac{13}{16}$x$\frac{23}{32}$	Bz $\frac{3}{4}$x$\frac{3}{4}$x$\frac{3}{4}$	ND 3203	ND 7109	BCA CTDS-56	ND 47508	14 rol. 1294780 (GM)	ND 47508-7	Nb	BSb $\frac{7}{8}$x1x1	7
8	Cadillac 67, 75	ND 88016	Cl frame	Bz $\frac{3}{4}$x$\frac{13}{16}$x$\frac{23}{32}$	Bz $\frac{7}{16}$x$\frac{3}{4}$x$\frac{3}{4}$	ND 3203	ND 7109	BCA CTDS-56	ND 47508	14 rol. 1294780 (GM)	ND 47508-7	Nb	BSb $\frac{7}{8}$x1x1	8
9	Chevrolet	ND 954252	$\frac{1}{2}$x$\frac{13}{16}$	None	Bz $\frac{13}{16}$x$\frac{13}{16}$x$\frac{11}{16}$	ND 3203	Hy 99004	ND CT-22	ND 43207	14 rol. $\frac{3}{16}$x$\frac{13}{32}$	ND 43305	Bz $\frac{7}{8}$x1x1$\frac{1}{4}$	Bz $\frac{7}{8}$x1x1$\frac{1}{4}$	9
10	Chrysler-Roy. & Win. C-34	OL (a)	(b)	(c)	OL .627x.755x.968	MR 203-S	OL .753x.941x.875	AB A-903 or BCA 4950-A	(e)	14 rollers .218x.531	(i)	22 rol. .1249x.930 (k)	22 rollers .1249x.930	10
11	Chrysler-Sar. & N.Y. C-36	MR 5200-FFS-4	(b)	(c)	OL .627x.755x.968	MR 203-S	(d)	AB A-903	(f)	14 rollers .218x.531	(i)	22 rol. .1249x.930 (k)	22 rollers .1249x.930	11
12	Chrysler-Crown Imp. C-37	MR 5200-FFS-4	(b)	(c)	OL .627x.755x.968	MR 203-S	(d)	AB A-903	(g)	14 rollers .218x.531	(i)	22 rol. .1249x.930 (k)	(m)	12
13	Crosley '42	None							Fed 1205-CG	CG No. 8	Fed 1204-FF	CG No. 8	CG No. 8	13
14	De Soto-DeL. & Cust. S-10	OL (a)	(b)	(c)	OL .627x.755x.968	MR 203-S	OL .753x.941x.875	AB A-903 or BCA 4950-A	(p)	14 rollers .218x.531	(i)	22 rol. .1249x.930 (k)	22 rollers .1249x.930	14
15	Dodge-DeL. & Cust. D-22	OL (a)	(b)	(c)	OL .627x.755x.968	MR 203-S	OL .753x.941x.875	AB A-903 or BCA 4950-A	(h)	14 rollers .218x.531	(i)	22 rol. .1249x.930 (k)	22 rollers .1249x.930	15
16	Ford-Six						PBB	AB A-893	Radial ball		Radial ball	Two rollers	Bz	16
17	Ford-Eight						PBB	AB A-893	Radial ball		Radial ball	Two rollers	Bz	17
18	Hudson-Six & DeL. 20		AL MZ-40A	AL MAB-124	AL GBF-79	ND 3203	ND 3200	BCA 1.625x2.593	ND 47507	Ban .187x.527	ND 43206	BSb	BSb	18
19	Hudson-Super. & Com. 6 21, 22		AL MZ-40A	AL MAB-124	AL GBF-79	ND 3203	ND 3200	BCA 1.625x2.593	ND 47507	Ban .187x.527	ND 43206	BSb	BSb	19
20	Hudson-Com. 8 24, 25		AL MZ-40A	AL MAB-124	AL GBF-79	ND 3203	ND 3200	BCA 1.625x2.593	ND 47507	Ban .187x.527	ND 43206	BSb	BSb	20
21	Hudson-Com. Cust. 8 27		AL MZ-40A	AL MAB-124	AL GBF-79	ND 3203	ND 3200	BCA 1.625x2.593	ND 47507	Ban .187x.527	ND 43206	BSb	BSb	21
22	Lincoln-Zeph. & Cont.							AB A-89[illegible]		Roller		Roller	Bz	22
23	Lincoln-Custom							AB A-893		Roller		Roller	Bz	23
24	Mercury						PBB	AB A-893	Radial ball		Radial ball	Two rollers	Bz	24
25	Nash-Ambassador 600 42-40	Bu						AB A-1609		Ball	Ball	Bu	Bu	25
26	Nash-Ambassador 6 42-80	Pl	AL MZ-40A	AL MAB-49A	SAE 203	SAE 203		AB A-899-2		Rollers	ND 7207	Bu .864x1.00x1.500	Bu .864x1.00x1.500	26
27	Nash-Ambassador 8 42-80	Pl	AL MZ-40A	AL MAB-49A	SAE 203	SAE 203		AB A-899-2		Rollers	ND 7207	Bu .864x1.00x1.500	Bu .864x1.00x1.500	27
28	Oldsmobile-Special Six 66	ND 954210 (GM)	Pl $\frac{7}{16}$x$\frac{13}{16}$	None	Bz $\frac{3}{4}$x$\frac{23}{32}$	ND 3203	Du 412562 (GM)	Gra 411538 (GM)	ND 47507	Rol 1294780 (GM)	ND 7506	Nb 1302154 (GM)	Bz 1307898 (GM)	28
29	Oldsmobile-Dynamic Six 76	ND 954210 (GM)	Pl $\frac{7}{16}$x$\frac{13}{16}$	None	Bz $\frac{3}{4}$x$\frac{23}{32}$	ND 3203	Du 412562 (GM)	Gra 411538 (GM)	ND 47507	Rol 1294780 (GM)	ND 7506	Nb 1302154 (GM)	Bz 1307898 (GM)	29
30	Oldsmobile-Special 8 68	ND 954210 (GM)	Pl $\frac{7}{16}$x$\frac{13}{16}$	None	Bz $\frac{7}{16}$x$\frac{23}{32}$	ND 3203	Du 412562 (GM)	Gra 411538 (GM)	ND 47507	Rol 1294780 (GM)	ND 7506	Nb 1302154 (GM)	Bz 1307898 (GM)	30
31	Oldsmobile-Dynamic 8 78	ND 954210 (GM)	Pl $\frac{7}{16}$x$\frac{13}{16}$	None	Bz $\frac{7}{16}$x$\frac{23}{32}$	ND 3203	Du 412562 (GM)	Gra 411538 (GM)	ND 47507	Rol 1294780 (GM)	ND 7506	Nb 1302154 (GM)	Bz 1307898 (GM)	31
32	Oldsmobile-Custom 8 98	ND 954210 (GM)	Pl $\frac{7}{16}$x$\frac{13}{16}$	None	Bx $\frac{7}{16}$x$\frac{13}{16}$	ND 3203	Du 412562 (GM)	Gra 411538 (GM)	ND 47507	Rol 1294780 (GM)	ND 7506	Nb 1302154 (GM)	Bz 1307898 (GM)	32
33	Packard-Six 2000-2020		AL MZ-40A	AL MAW-130	AL GBF-79	ND 3203	MR 7109	BCA 4765-A	SKF 465699	BCA 94516	MR 207-SG	Ban B-1316-Q	Bu	33
34	Packard-Eight 2001-2021		AL MZ-40A	AL MAW-130	AL GBF-79	ND 3203	MR 7109	BCA 4765-A	SKF 465699	BCA 94516	MR 207-SG	Ban B-1316-Q	Bu	34
35	Packard-Sup. 8 2003-23-4-5		AL MZ-40A	AL (o)	AL GBF-79	ND 3203	SKF FL-6205-Z	BCA 4506-A	SKF 465699	BCA 94516	MR 207-SG	Ban B-1316-Q	Bu	35
36	Packard-Cus. Sup. 8 2006-7-8		AL MZ-40A	AL (o)	AL BGF-79	ND 3203	SKF FL-6205-Z	BCA 4506-A	SKF 465699	BCA 94516	MR 207-SG	Ban B-1316-Q	Bu	36
37	Plymouth-DeL. & Spec. DL. P-14	OL (a)	(b)	(c)	OL .627x.755x.968	MR 203-S	OL .753x.941x.875	AB A-935-1 or BCA 4950-A	(h)	14 rollers .218x.531	(i)	22 rol. .1249x.930 (k)	22 rollers .1249x.930	37
38	Pontiac-DeLuxe 6 42-25	ND954210 (GM)	Cl .562x$\frac{13}{16}$	OB $\frac{1}{2}$x$\frac{7}{16}$x$\frac{23}{32}$	Du 812823 (GM)	ND 3203	ND 7109	Gra	ND 47507	Rol 1294780 (GM)	ND 7506	Rol 1302154 (GM)	Bz .850x.987x$\frac{3}{4}$	38
39	Pontiac-Stream. 6 42-26	ND 954210 (GM)	Cl .562x$\frac{13}{16}$	OB $\frac{1}{2}$x$\frac{7}{16}$x$\frac{23}{32}$	Du 812823 (GM)	ND 3203	ND 7109	Gra	ND 47507	Rol 1294780 (GM)	ND 7506	Rol 1302154 (GM)	Bz .850x.987x$\frac{3}{4}$	39
40	Pontiac-DeLuxe 8 42-27	ND 954210 (GM)	Cl .562x$\frac{13}{16}$	OB $\frac{1}{2}$x$\frac{7}{16}$x$\frac{23}{32}$	Du 812823 (GM)	ND 3203	ND 7109	Gra	ND 47507	Rol 1294780 (GM)	ND 7506	Rol 1302154 (GM)	Bz .850x.987x$\frac{3}{4}$	40
41	Pontiac-Stream. 8 42-28	ND 954210 (GM)	Cl .562x$\frac{13}{16}$	OB $\frac{1}{2}$x$\frac{7}{16}$x$\frac{23}{32}$	Du 812823 (GM)	ND 3203	ND 7109	Gra	ND 47507	Rol 1294780 (GM)	ND 7506	Rol 1302154 (GM)	Bz .850x.987x$\frac{3}{4}$	41
42	Studebaker Champion 6 4G	ND 885162	AL MZ-40A	AL MAB-124	AL GBF-79	SAE 203	BC $\frac{5}{8}$x$\frac{13}{16}$x$\frac{3}{4}$	AB 935-2 or BCA 4768-A	Ball 1207	Ban C-1110-Q	Ball 1206	CG $\frac{5}{8}$x$\frac{3}{4}$x1$\frac{1}{4}$	CG $\frac{5}{8}$x$\frac{3}{4}$x1$\frac{1}{4}$	42
43	Studebaker-Commander 6 12A	BC $\frac{1}{2}$x1x1$\frac{1}{4}$	AL MZ-40A	..... $\frac{1}{2}$x.628x$\frac{47}{64}$	AL GBF-79	SAE 203	BC $\frac{3}{4}$x$\frac{13}{16}$x$\frac{7}{8}$	AB A-899-2	Ball 1207	WG 14 rol. $\frac{7}{16}$x$\frac{13}{32}$	Ball 1207	Ban C-407-Q	Bz $\frac{3}{4}$x.887x1$\frac{1}{16}$	43
44	Studebaker-President 8 8C	NM	AL MZ-40A	$\frac{1}{2}$x.628x$\frac{47}{64}$	AL GBF-79	SAE 203	Hy RA-133	AB A-899-2	Ball 1207	WG 14 rol. $\frac{7}{16}$x$\frac{13}{32}$	Ball 1207	Ban C-407-Q	Bz $\frac{3}{4}$x.887x1$\frac{1}{16}$	44
45	Willys-Americar 442	ND 885141 (GM)	AL MZ-40A	AL MG-77A	AL GBF-79	ND 3203	Bu	AB A-935-1	Fed 1207	Hy RA-93218	Fed 1305-CGF	Bu	Bu	45

ABBREVIATIONS:

(a)—.596x1.128x1.406—Front .671x.879x.938—Rear
(b)—Oilite .637x.754x.594 or Auto-Lite MZ-40-A
(c)—Oilite .501x.627x.735 or Auto-Lite MP-41-A
(d)—Fluid Drive Hub bearing Marlin-Rockwell 207-SF or SKF-I-71658-B
(e)—Marlin-Rockwell 307-SFG-1 or SKF-I-70822-R
(f)—Marlin-Rockwell 307-MFG-1 or SKF-465679-R
(g)—Marlin-Rockwell 307-MFG-1 or SKF-466237-R
(h)—Marlin-Rockwell 207-SFG or SKF-I-71659-R
(i)—MR-207-S, SKF-I-71658-B, or WG-X-3204 or X-3204-X
(k)—Two sets required
(m)—OL .805x.938x1.156 or CG .805x.940x1.156
(o)—MAW-77 on armature shaft, MG-77A on clutch shaft
(p)—Marlin-Rockwell 207-MFG or SKF-I-70822-R
AB—Aetna Ball Bearing Mfg. Co.
AL—The Electric Auto-Lite Company
Ban—Bantam Bearing Co.
BC—Bound Brook Co.
BCA—Bearings Company of America, Inc.
Bu—Bushing
Bz—Bronze bushing
CG—Cleveland Graphite Bronze Co.
Cl—Cast iron
Du—Durex-Moraine Products Division
Fed—Federal Bearing Co.
(GM)—General Motors number
Gra—Graphite ring
MR—Marlin-Rockwell Corp.
Nb—Needle bearing
ND—New Departure Division
NM—New Departure or Marlin-Rockwell
OB—Oilless bushing
OL—Oilite
PBB—Prelubricated type ball bearing
Pl—Plain bearing
Rol—Roller bearing
SAE—Society of Automotive Engineers, standards number
WG—Warner Gear Division



Inspecting and checking run-out of spindle on Milwaukee Model K Vertical Type Milling Machine — another exacting inspection which every Milwaukee Milling Machine must pass.

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Milwaukee MILLING MACHINES

Powder Metallurgy

Applications in mass fabrication of automobile parts

(Continued from page 34)

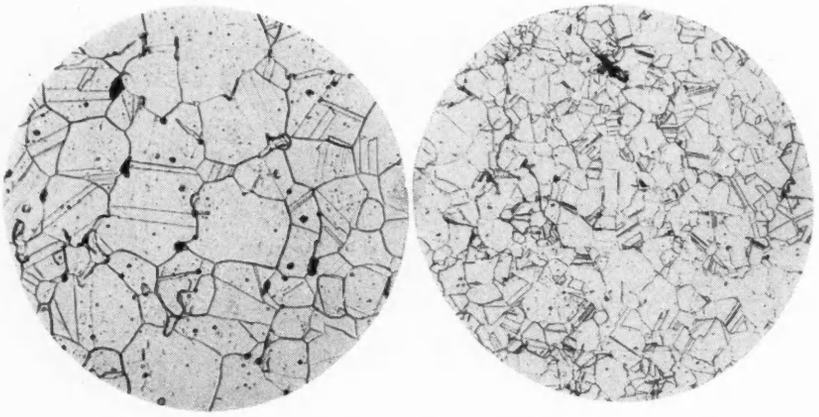

Fig. 2—Hastelloy B sintered (left) and the same material after 25 per cent reduction by hot swaging (right) shows marked grain refinement.

By Floyd C. Kelly

cost increases greatly. The largest presses are not automatic, but hand operated; so the cost of production increases with increase in size.

There is another difficulty encountered with the increase in size, and that is the non-uniform distribution of pressure throughout the compact, resulting in uneven shrinkage if the temperature of sintering is sufficiently high. If the temperature is low, then there is non-uniform density throughout the compact.

The cost of dies for pressing complicated shapes is high, and unless many thousands can be made the cost per piece may be prohibitive. On the other hand, millions of small parts can be turned out on automatic presses, amounting to tons of material at very low cost.

There is no machining cost, which is relatively large when similar parts are turned from solid stock, and then they are not self-lubricating. There is very little loss of material as scrap. In the case of a gear, this may run as high as 75 per cent when made from solid stock. The loss of material plus the cost of machining are saved by the powder process.

Intricate shapes may be formed with a single stroke of the press and the size maintained by proper sintering or a cold coining operation after sintering. Bearings backed by solid steel and filled with oil do not require high strength and in many applications no additional lubrication throughout the life of the bearing.

The iron powders used in our experiments were all of high purity. The particle size was —200 mesh with about 50 per cent being —325 mesh. Five gram samples were used for these tests, and they were pressed in a steel mold, using a hand-operated hydraulic press so the pressure could be obtained very accurately. The size of the bars was ⅛ in. x ¼ in. x 1¼ in. This small sample was used to secure as uniform pressure as possible throughout the compact.

Seven different pressures were used for the iron samples, and they were all sintered at 1425-1450 deg. C. for 32 hr. in hydrogen. At this high temperature of sintering, pressures of 30-60 tons per sq. in. gave the highest densities. When the pressure was 30

Hastelloy B Specimens

Mixture of Hydrogen Reduced—Molybdenum Oxide, Electrolytic Nickel, and Electrolytic Iron

No.	Particle Size	Pressure p. s. i.	Sintering Temperature	Time	% Shrinkage	Temperature of Test	T. S. p. s. i.	T. S. after 25% Reduction	% Elongation	% Reduction of Area	Density	Rockwe B Hardness
C28	—200	60,000	1250°C	24 hr.	10.4	1500°F	.....	86,000	10.8	13.0	....	....
C29	—200	60,000	1250°C	24 hr.	15.3	Room	87,000	.....	20.0	11.95	8.16	68.0
C30	—200	60,000	1250°C	24 hr.	13.9	Room	85,000	.....	21.0	15.44	8.25	72.3
C31	—200	60,000	1250°C	24 hr.	16.5	1500°F	43,000	.....	8.0	8.0	8.2	70.7

Mixture of Hydrogen Reduced—Oxides of Molybdenum, Nickel and Iron

C32	—325	60,000	1250°C	24 hr.	45.0	1500°F	.....	61,000	5.0	5.5	....	....
C33	—325	60,000	1250°C	24 hr.	46.0	Room	98,600	.....	.013	6.53	9.2	101.8
C34	—325	60,000	1250°C	24 hr.	45.8	Room	96,200	.....	.013	6.96	9.2	102.8
C35	—325	60,000	1250°C	24 hr.	47.8	1500°F	44,000	.....	5.0	4.0	9.26	103.0

Effect of Time

99.5MoO_3+Ni and Fe Oxides. Sintered at 1250°C

D8	.....	60,000	.....	2 hr.	32.6	.....	.....	.....	....	....	8.63	94.3
D9	.....	60,000	.....	4 hr.	46.9	.....	.....	.....	....	....	8.6	92.3
D10	.....	60,000	.....	8 hr.	46.6	.....	.....	.....	....	....	8.83	89.5
D11	.....	60,000	.....	16 hr.	48.9	.....	.....	.....	....	....	8.92	96.5
D12	.....	60,000	.....	24 hr.	45.8	.....	.....	.....	....	....	9.0	96.0

NO. 9

ALUMINUM, DEFENSE, AND YOU

SIX MORE PLANTS IN FIVE STATES ON THE WAY

DEFENSE PLANT CORPORATION OWNS THEM. We've been designated to build them . . . fast.

Actually, when the names went on the dotted lines of the contract on August 19, we had already placed more than $16,000,000 worth of orders for some of the equipment and materials it takes longest to make and get.

FIVE OF THESE PLANTS will smelt aluminum. Their combined capacity is planned for more than 500,000,000 pounds a year, which is greater than the nation's entire production of aluminum in 1940. Locations: Massena, N. Y., Spokane, Wash., Troutdale, Ore., Los Angeles, and in the State of Arkansas.

The sixth plant will refine alumina from bauxite. Its billion-pounds-a-year capacity adds 58% to the nation's alumina capacity. It will be located at Bauxite, Arkansas.

HOW GOES CONSTRUCTION? At this writing, as fast as title is secured to the sites, contracts are being let for grading and foundations so as to be ready for the structural steel, which is coming as rapidly as it can be gotten.

What is more important, the aluminum plants are scheduled to deliver ingot by the summer of 1942; the refining plant to deliver alumina in early summer, 1942.

WE'VE ASSIGNED a large staff of men full time to headquarters engineering, purchasing, and accounting on this government building job.

We're sending competent and experienced management men out on these jobs as superintendents and other staff executives on construction, and for subsequent operation of such of these plants as we are designated to operate.

EVERY KNOWN IMPROVEMENT in design and construction and equipment is being incorporated in these plants. We intend that every dollar that will be spent shall be the best dollar's worth that experience can build. We do not make one cent of profit from this assigned job of construction.

We think we know how to get the government value-received for its money, because we are completing the expenditure of more than $200,000,000 of our own money in an expansion program which started after the beginning of the present war. Some of this expenditure is in new alumina and aluminum plants which will bring our own Alcoa capacity up to more than 700,000,000 pounds a year. The remainder is in tremendous expansion of facilities for fabricating every form of aluminum.

DEFENSE, GENTLEMEN, is getting its aluminum.

ALUMINUM COMPANY OF AMERICA

tons per sq. in. and the time was 32 hr., between 1350 deg. and 1400 deg. C. there is a marked increase in density. It seems that 32 hr. sintering is not quite long enough to secure the theoretical density of pure iron, or 7.86. With a pressure of 30 tons per sq. in. and the temperature 1425 deg. to 1450 deg. C., 64 hr. were required to secure the theoretical density.

A series of nickel samples was pressed and sintered at 1375 deg. to 1400 deg. C. for 32 hr. in hydrogen. The theoretical density of 8.9 was not quite reached in 32 hr., as was the case with iron. The optimum pressure range seems to be 40-60 tons per sq. in. Fig. 1 is a photomicrograph of nickel made from hydrogen-reduced nickel oxide and sintered in the same way.

For cobalt samples pressed and sintered at 1375 deg. C. for 32 hr. in hydrogen, there was an optimum pressure range of 10-40 tons per sq. in. which gives the highest density. This density comes within the range 8.6-8.9.

These results on the sintering of pure metals at temperatures close to their melting points show quite conclusively that sound bars may be obtained from pressed and sintered compacts when sintered for long enough time. They also indicate that each metal has an optimum pressure where the highest densities may be obtained. Temperature and time are the most important factors in obtaining sound materials from pressed powders. Pressure is the least important. Highest pressures in every case gave densities below those obtained over the optimum pressure range.

An alloy of Fe-Ni-Co known as Fernico has been produced by the sintering process. It has all of the physical characteristics of the same material made by melting.

The theoretical fellow might say that the establishment of equilibrium in such a system could never be accomplished. As a matter of fact, we seldom deal with alloys which are in equilibrium, and it is an outstanding example of a material produced from powdered metals which must meet such exacting physical characteristics as are required by a metal sealed to glass.

Nickel-molybdenum and nickel-tungsten alloys made by sintering have been produced, which when welded to nickel, produce couples which are capable of operating up to 1300 deg. C. for the former and 1400 deg. C. for the latter in hydrogen furnaces. Tests on NiMo-Ni couples over periods above 3000 hr. at high temperatures have shown that they do not vary more than ± 5 deg. C. from the original calibration. No tests of such long periods have been made on the NiW-Ni couples, but there is no reason why they should not give equal performance at 1300 deg. C. for equal length of time.

We have pressed and sintered 18-8 from mixtures of iron, chromium, and nickel powders. The results of tests made on the mixed powders pressed at 30 tons per sq. in. and sintered from 32 hr. at 1375 deg. C. were as follows: The percentage shrinkage in volume varied from 20-25 per cent. The tensile strength at room temperature was 79,250 psi and at 1500 deg. Fahr. it was 19,500 psi. When reduced 25 per cent by swaging, the tensile strength at 1500 deg. Fahr. was 24,500 to 27,500 psi. The elongation and reduction of area were not taken at room temperature, but at 1500 deg. Fahr. the elongation was 27 per cent and reduction of area 20 per cent. Allegheny Ludlum Steel Co. gives 80,000 psi as the ultimate strength with 55 per cent elongation and 65 per cent reduction of area of annealed 18-8.

For 18-8 bars sintered at 1375 deg. C. for 24 hr. in pure hydrogen, it is quite interesting to note that with a decrease in particle size the percentage shrinkage in volume decreases. This is exactly the reverse of what we generally get with iron powders. The elongation and reduction of area increase with the decrease in particle size.

Hastelloy B (65 Ni, 28 Mo, 7 Fe alloy) has relatively high strength at high temperature and has been made from electrolytic nickel and iron and hydrogen-reduced molybdenum and also

Cut down bearing failures and prevent delays in producing defense orders

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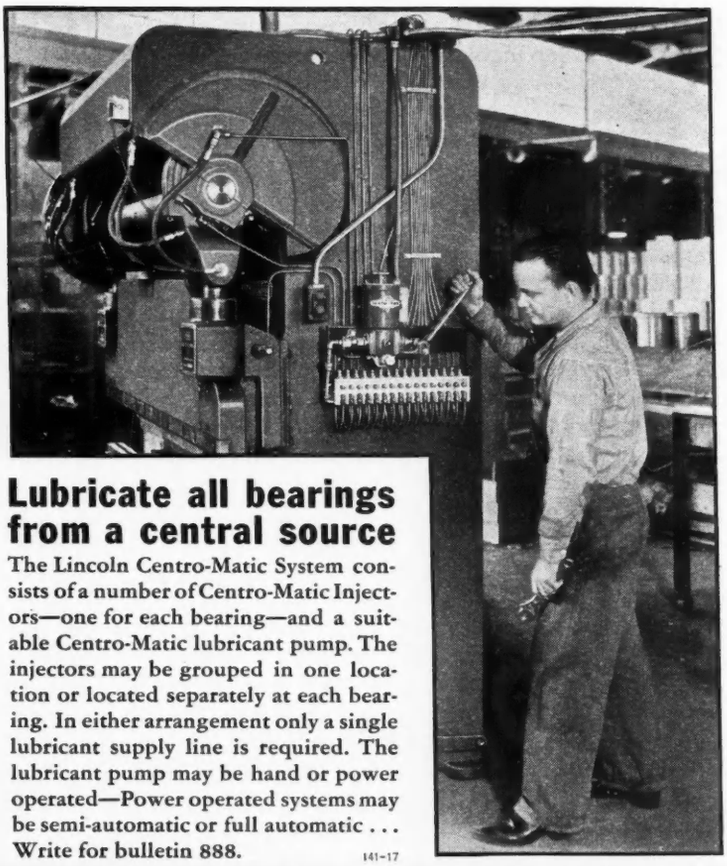

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from reagent oxides hydrogen reduced to give the metals. Interesting results (see table on page 56) were obtained in a series of tests with this material.

Note the great difference in shrinkage between the C28-C31 and C32-C35. The higher hardness of C33-C35 is typical of hydrogen-reduced metals. The greater ductility of C28-C31 is very marked. The greater strength of C33 and C34 is to be expected on account of their higher densities and hardness. Yet after 25 per cent reduction by hot swaging, C28 shows as high strength at 1500 deg. Fahr. as C29 and C30 do at room temperature; and C32 after 25 per cent reduction by hot swaging shows less strength at 1500 deg. Fahr. than either C33 or C34 do at room temperature. There is little difference in the strengths of the as-sintered samples C31 and C35 at 1500 deg. Fahr.

The effect of time of sintering on shrinkage, density, and hardness is given by samples D8-D12. The greatest part of the shrinkage occurs in the first 4 hr., but the density and hardness increase steadily with time.

Fig. 2 shows the structure of sintered Hastelloy B and also for the same material after 25 per cent reduction by hot swaging. The hot-worked specimen shows very little porosity. The grain refinement due to the hot swaging is very marked.

Powder Metallurgy

(*Continued from page* 35)

By Herbert Chase

which is sufficient to produce a sintering action. Carriers are made of a heat-resistant alloy. It requires 16 to 17 min. for passage through the furnace.

At the discharge end, the heated briquettes are picked up one at a time by tongs and are dropped into a die in a 900-ton press, the carrier being pushed onto a plate conveyor which returns it to the charging end of the furnace. In the die, there is a central mandrel which fits the hole in the briquette and against which it is compressed by eight radial jaws. This avoids upsetting the mandrel. The ram applies axial pressure simultaneously. As a result, the volume is again reduced, this time by about one third, the pressure applied being between 30 and 50 tons per sq. in.

Upon discharge from the die which turns out 550 pieces an hour, the ring is quenched in water and then is put through a trimming die which removes the flash formed at die partings. Thereafter, the only other operations required are to coin the rings and then shot blast them, the latter removing any burrs, loose particles or scale. Dimensions which must be held are as shown on the drawing and in some instances must be within limits only 0.003 in. apart.

That the application of heat and pressure in the manner indicated results in fusing the metal is made evident by specifications which require that, when the piece is clamped so that half of it is held in a vise, the protruding half must withstand a pressure of 2500 lb. minimum applied by the pressure of a punch ¾ in. in diameter. This eccentric loading, which produces both shearing and bending stresses, has run in tests from 4000 to 4950 lb. (not per sq. in., but actual loading about 1¼ in. eccentric), which is three to four times that which the sand casings formerly used withstand. Rockwell B-scale hardness is required to be between 78 and 90 but commonly runs from 82 to 88.

As will be seen, the only cutting operation required in finishing the piece is that of trimming the flash, hence it is obvious that machining costs are far below those for a gray iron casting. The production rate is also much higher and, as the material cost is only the scrap value of the chips used, it too is well below that of the gray iron in the casting. Clearly then, over-all cost is well below that for the casting in its finished form and, as strength is superior, there is a net gain from all angles.

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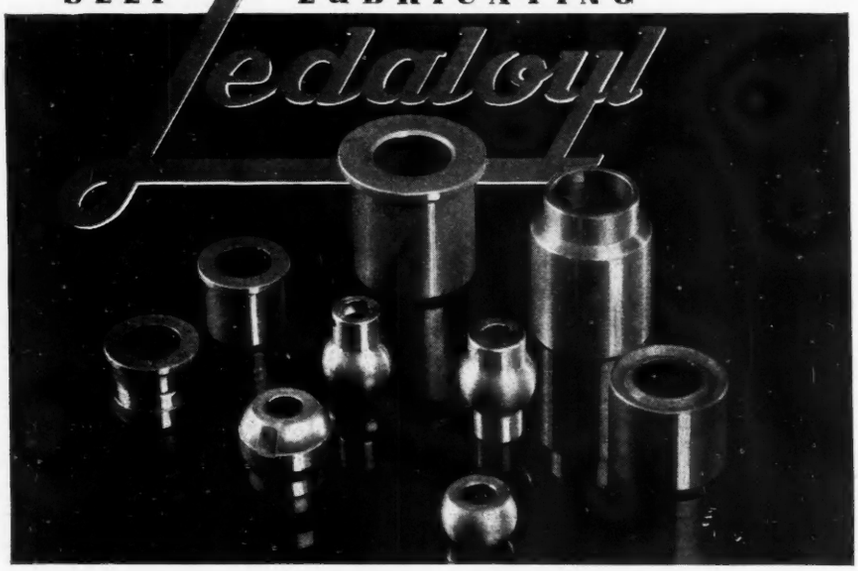

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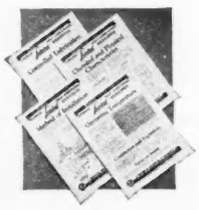

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Deliveries of tank and aircraft electrical equipment are well ahead of schedule at the Rochester Products Division of General Motors, according to Thomas H. Lee, general manager. The change-over from the manufacture of automotive electrical equipment to all-out defense production has been effected without any general work stoppage or lay-offs. Starting motors for airplane engines, including the Rolls-Royce produced in the U. S., generators, generator output controls, dynamotors, and alternators are being produced by this unit for the Eclipse Aviation Division of Bendix. For the balance of the year, production will be continued on seven items of equipment for the automobile industry; the production of 11 items has been discontinued already. After the first of the year, Rochester Products Division will be working 100 per cent on defense orders.

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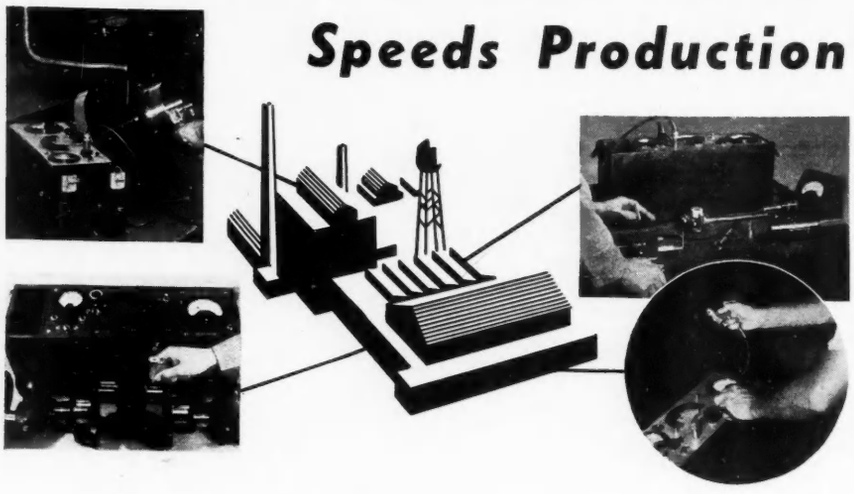

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The PROFILOMETER

PHYSICISTS RESEARCH COMPANY

343 SOUTH MAIN ST. • ANN ARBOR, MICH.

Business in Brief

Written by the Guaranty Trust Co. New York, Exclusively for AUTOMOTIVE INDUSTRIES

Renewed expansion of general business activity is indicated. The seasonally adjusted index of The New York *Times* for the week ended Nov. 29 rose 3.6 points to 133.4 per cent of the estimated normal, an all-time peak, as compared with 119.3 a year ago. The index of *The Journal of Commerce*, without seasonal adjustment, for the same period, reflecting recovery from the effects of the Thanksgiving holiday, advanced to 126.5 per cent of the 1927-29 average from 121.4 for the week before.

Department store sales during the week ended Nov. 29, according to the Federal Reserve compilation, were 15 per cent above the corresponding total last year, as compared with a similar gain of 11 per cent for the preceding week.

Contracts awarded for heavy construction during the week ended Dec. 4, totaling $93,488,000, were 15 per cent below the comparable amount last year; but the 1941 total to date is 54 per cent greater than the similar sum a year earlier, according to *Engineering News-Record.*

Railway freight loadings in the week ended Nov. 29 totaled 866,189 cars, 8.3 per cent more than for the week before, and exceeded the number in any corresponding period since 1929.

Business failures during the week ended Nov. 27 numbrd 203, as against 188 for the preceding week and 258 a year ago, according to the Dun & Bradstreet report.

Electric power production in the week ended Nov. 29 increased less than seasonally and was 12.3 per cent above the output a year ago, as compared with a similar advance of 12.9 per cent a week earlier.

Crude oil production during the same period averaged 4,086,600 barrels daily, 250,250 barrels below the average for the week before but 16,600 barrels more than the currently required output as computed by the Bureau of Mines.

Average daily output of bituminous coal during the week ended Nov. 29 was 1,858,000 tons, as compared with 1,613,000 tons in the preceding week and 1,690,000 tons a year ago.

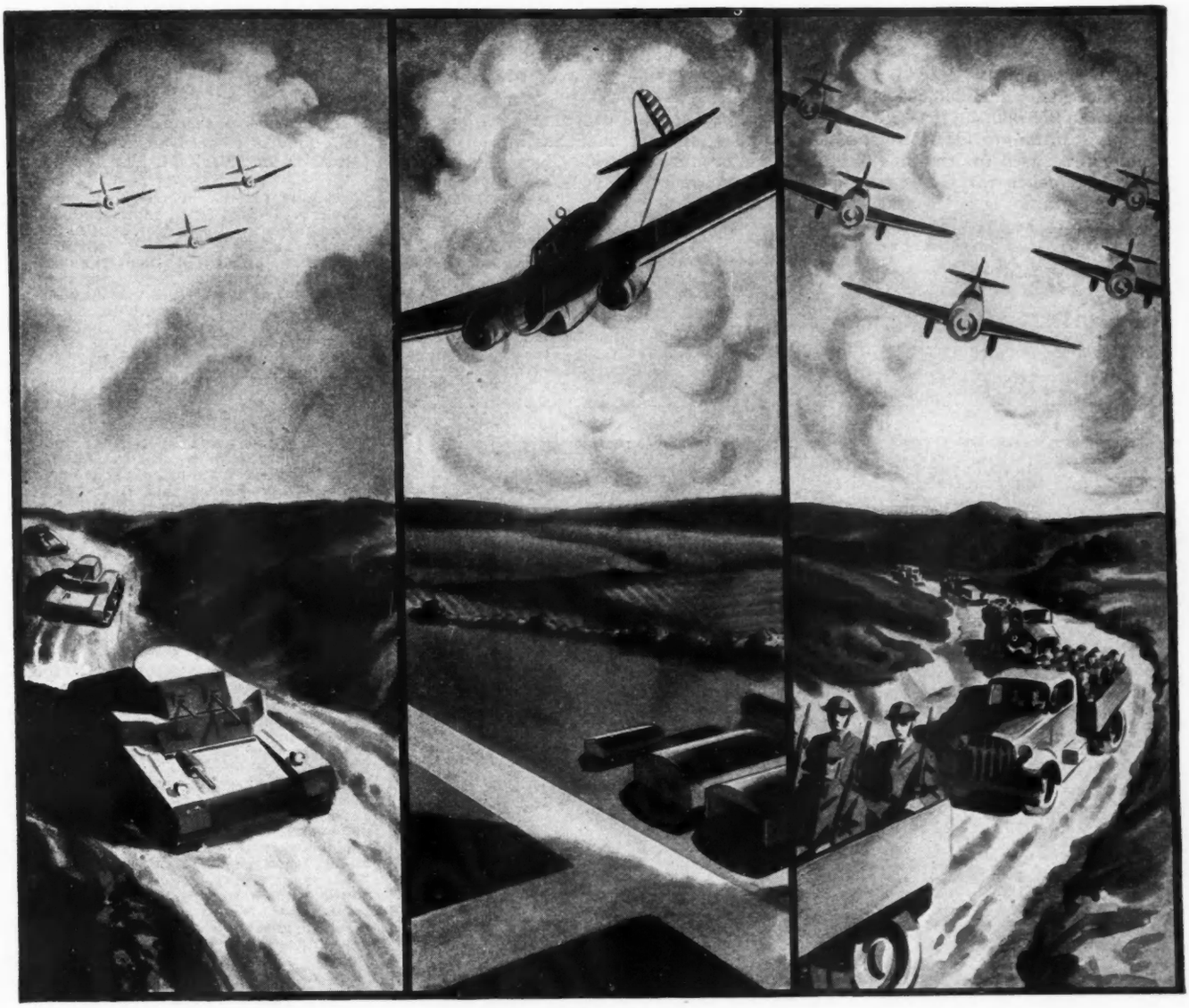
Cotton mill activity in the same period, according to the index of The New York *Times*, rose to 161.6 per cent of the estimated normal, as against 154.1 for the week before and 139.3 a year ago.

Professor Fisher's index of wholesale commodity prices for the week ended Dec. 5 advanced two fractional points to 99.2 per cent of the 1926 average, a new peak for the period since 1929.

Member bank reserve balances rose $52 million during the week ended Dec. 3, and estimated excess reserves increased $60 million to a total of $3,860,000,000.

Army Tests Oil Reclaimer

A new mobile oil reclaimer designed to purify used crankcase oil has been designed for the Quartermaster Corps. The unit is capable of handling used oil from more than 3000 vehicles per month. It was tested under actual maneuver conditions in South Carolina.



INDUSTRIAL SUPREMACY...Yesterday Becomes DEFENSE SUPREMACY...Today

FOR over 20 years this organization, through its pioneering work in aluminum alloy castings, contributed to the sensational engineering advancements made by the automotive and aircraft industries.

Today, an ever-increasing output of Permite Aluminum and Magnesium Alloy Castings and other Permite Products is going into American-built bombers, pursuit ships, tanks, trucks and many types of equipment that are setting unexcelled records of efficiency and performance in the defense of liberty.

We are proud to turn the skill that has helped make America supreme industrially into today's program to make our country supreme in the defense of freedom.

Completion of the first unit of our vast new building program has greatly increased our production facilities. If you need pistons, cylinder heads, valves, aluminum or magnesium alloy castings, of permanent mold or sand types, these expanded facilities are at your service as promptly and completely as our part in the national defense program will permit.

ALUMINUM INDUSTRIES, Inc., Cincinnati, Ohio

Branch Sales and Engineering Offices:
DETROIT, 902 New Center Bldg.
CHICAGO, 616 So. Michigan Ave.
LOS ANGELES, 324 N. San Pedro St.

PERMITE PRODUCTS

ALUMINUM AND MAGNESIUM ALLOY CASTINGS • STEEL PRODUCTS • PAINTS

Lockheed Expands

Lockheel Aircraft Corp. boosted its total floor space to 2,243,000 sq. ft. by leasing the 350,000 sq. ft. Willys Overland plant in Maywood, California. The plant will be used for the manufacture of sub-assemblies for Hudson bombers and for storage. Two months will be required for the installation of equipment before the new plant goes into operation.

Harrison Layoffs Increase

The Harrison Radiator Division of General Motors Corp., Lockport, N. Y., is gradually discharging its employees until the plant is shifted from non-defense to defense work. A spokesman for General Motors said "the layoffs are the result of material shortages, largely copper, for the manufacture of heaters for automobiles. There is no indication when more copper will be available.

Detroit Eng. Society Moves

The Engineering Society of Detroit has moved its executive offices from the Hotel Statler to permanent quarters in the Horace H. Rackham Educational Memorial, 100 Farnsworth St., Detroit.

CENSORED

An exclusive feature prepared by the London correspondent of AUTOMOTIVE INDUSTRIES, M. W. Bourdon.

Manufacturers, distributors and dealers in the British motor industry have presented a squadron of 21 fighter airplanes to the nation. Individual firms have given 16 of them, the other five being paid for by donations received from members of various associations. Among firms giving one or more machines are Austin, Champion Plug, Dunlop, Ford, Nuffield group, Rootes group and Vauxhall (G.M.C.). Vauxhall dealers have also given one, and Lord Nuffield has donated one on his own account.

* * *

Farm tractors and other farm implements imported under the terms of the Lease-Lend Act will be sold henceforth by the Government to farmers only, and the need for their acquisition in each case must be certified by executive committees representing the Ministry of Agriculture. Sales will be on a cash basis only, and purchasers will not be allowed to resell except with the consent of the Ministry. Distribution will be made through ordinary trade channels at controlled prices.

* * *

One result of the report of the Motor Vehicle Maintenance Advisory Committee (which consisted of manufacturers, operators, and repairers appointed to make recommendations to overcome the shortage of replacements and repairshop labour) is that manufacturers will ration spare parts to prevent hoarding and that hoarded parts will be requisitioned. No replacements will be supplied except for vehicles actually or likely to be immobilized through want of new parts. When a new or reconditioned part is obtained the old part must be returned to the manufacturers. The committee also advised that the building of non-standard vehicles from parts salvaged from scrapped vehicles should be prohibited.

* * *

A "flying column" has been organized by the London, Midland and Scottish Railway Co. to give first-aid to the company's fleets of trucks damaged in air raids when and where existing repairshops have also suffered from enemy attack or facilities for repairs are remote. Accompanying a mobile workshop—with welding plant, machine tools, fitters' tools and benches, its own power and lighting, replacement parts, tires, and timber for repairing bodywork—is a container canteen for operatives.

* * *

The first of a fleet of mobile pharmacies is now in readiness for emergency service in seriously bombed areas. Besides a big range of medicants, there are facilities for treating light casualities, including eye injury, by trained attendants. Three similar vehicles are being provided by British and American donations, the latter including 4,000 dollars from employees of the Consolidated Aircraft Corp., San Diego, California.

* * *

New basic gasoline rations (for recreational, domestic or other private use) still further discourage the use of large cars. The allowances for each three-monthly rationing periods now range from 13 gal. for eight to nine horse power cars to 24 gal. (instead of 30 gal.) for cars of 20 hp. and over. So, while an "Eight" will cover about 2000 miles on its annual allowance, a "Thirty" will do well to cover 1200 miles during the validity of its annual license which costs nearly £40!

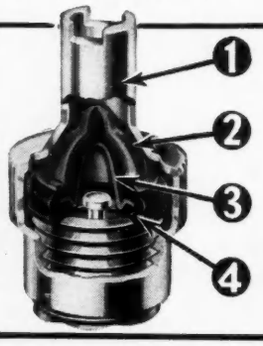
THE SAFETY SEAL OF MORE THAN 100,000,000 TIRE VALVES

This is the sealing unit of a standard Schrader Tire Valve Cap, enlarged more than eight times. See below, its unique construction features and how it makes an absolute seal at the tire valve mouth. Dirt and water can't get in. Even if the valve were damaged beyond repair, air could not escape.

The service records of leading truck, bus and taxi fleet operators show that the use of air-tight valve caps helps maintain more accurate tire pressures. As a result they get greater mileage, safer operation and have fewer roadside delays.

For customer safety and satisfaction, be sure the tubes you sell are equipped with standard tire valve caps.

A. SCHRADER'S SON, BROOKLYN, N. Y.
Division of Scovill Manufacturing Co., Inc.



Here's an Inside View of a Schrader Tire Valve Cap

1. Valve Cap body or shell.
2. Brass Swivel Plate allows Cap Shell to turn independently of rubber washer as Cap is applied. This assures proper seating of washer and prevents distortion.
3. Brass Dome-Shaped Plate provides an indestructible chamber for safe clearance of valve core pin.
4. Molded Rubber Washer seals valve mouth when Cap is screwed on firmly by hand; while rubber between brass plates 2 and 3 provides spring action to maintain positive seal.

Schrader Tire Valve Caps

Guaranteed air-tight up to 250 lbs. pressure.

Current notes on BETHLEHEM ALLOY STEELS

GEAR STEELS

The airplane, the automobile and practically every other type of mechanism, light or heavy, employs a number of gears. To meet the varied needs of a host of manufacturers, a number of alloy steels have been developed which may be grouped in the general classification of gear steels. Thus, the current exacting demands of ultra-heavy-duty military trucks, tanks and gun carriages find the engineer and designer already equipped with special steels suited to these and other defense applications.

Since hardness and toughness are both essential in gears, a number of alloy steels of carburizing grades are commonly used, as well as those of oil-hardening grades. These latter differ from carburizing grades in having higher carbon content—ranging, in the case of oil-hardening gear steels, from 0.45 to 0.60 per cent carbon. Gear steels of both grades include numbers of alloy steels containing nickel, chromium, molybdenum and vanadium in various combinations. Because of shortages of some of these alloying elements—notably nickel and chromium—a number of alloy gear steels are available only for direct defense applications. In non-defense applications, the designer's choice is limited to other steels, a number of which have been developed to meet this requirement.

The special care taken in production to insure cleanness in gear steels is a factor making for good machinability, but this quality depends also on correct annealing of forgings. Since minimum distortion in treatment is of great importance in production work on gears, extra care must be taken in heat-treating. In all cases, the recommended annealing and heat-treating practice for each specific steel should be followed closely.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

Ford May Produce 3500 Cars for December

Automobile production in the Buffalo assembly plant of the Ford Motor Co. will continue at a normal schedule of approximately 3500 units during December, supply conditions permitting.

The curtailment of production ordered for December by the OPM will not affect the Buffalo plant because parts have been diverted to Buffalo from other assembly units to permit greater defense production in the other plants.

Truck Production by Capacity

(U. S. and Canada)

	FIRST TEN MONTHS		
	Units		Per Cent of Total
	1941	1940	1941
1½ Tons and less	849,243	810,538	81.74
2 to 3 Tons	134,901	47,208	12.98
3½ Tons and over	22,613	13,266	2.18
Special and buses	14,405	6,626	1.39
Station Wagons	17,761	12,246	1.71
Total	1,038,923	889,884	100.00

GET DURO Tools NOW

FOR FACTORY-SHOP-TOOL ROOM

Now is the time to use Duro Power Tools. They are built to precision limits and, more important, they lend themselves to many jobs where speed and adaptability are essential.

We recommend—

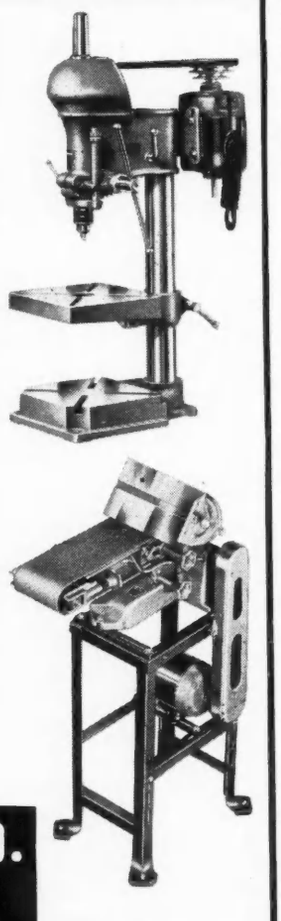
Single and multiple spindle Drill Presses to perform various drilling and tapping operations with speed and accuracy. Their massive construction guarantees continuous and trouble free performance.

The Belt Sander for fast removal of burrs from all materials or quick sanding and polishing hundreds of parts.

The Band Saws for cutting tubing, extruded shapes, bar stocks, metal sheets, gates on castings, plastics, brake linings, hard rubber, slate, fibre and many other materials, economically and efficiently.

Duro Heavy Duty Grinders for tool and die work. Their surplus power, high speed and precision performance make them important tools in today's frantic effort to produce materials.

The tools described here do not comprise the complete Duro Line. We again invite you to write for our latest catalog and if you have any problems we'll be glad to discuss them with you.



DURO METAL PRODUCTS CO.
DEPT. AI-12
2649 N. KILDARE AVE., CHICAGO, ILL.

PUBLICATIONS

National Broach & Machine Co. has a new leaflet, **Gears Can Be Improved By Lapping,** which describes and illustrates a final correction its Red Ring lapping provides for heat treat distortion and grinding roughness.*

A comprehensive manual, **Fundamentals of Storage Battery Construction and Operation,** covering all phases of automotive storage battery construction, has been issued by The B. F. Goodrich Co. Goodrich has also published a new catalog section on its **Plastikon rubber putty,** giving the properties, grades, directions for use and application.*

A new **Wheelco Condensed Catalog,** Bulletin Z4000 by Wheelco Instrument Co., provides a convenient, condensed listing of the principal items of equipment manufactured by them.*

The Van Keuren Co. has issued a 68-page catalog on **precision measuring tools,** giving information on light waves, instruments, gage blocks and measuring wires for all purposes.*

The Roxalin Flexible Lacquer Co. announces publication of a convenient file folder entitled **Facts on U. S. Government Finishes.** It contains data sheets on the widely used Army and Navy specification finishes and tells how and where they are applied.*

Despatch Oven Co. has issued a new illustrated bulletin, No. 73, on its **oil fired heaters.***

An article on **Automotive Gear Lubrication** is contained in the current issue of **The Institute Spokesman,** publication of the National Lubricating Grease Institute.*

Climax Molybdenum Co., 500 Fifth Avenue, N. Y., has issued revised sections for substitution in the book **Molybdenum in Steel,** presenting valuable data which were not available when the book was published. The sections so revised are Nos. 1, 5, 11, 12, General Index and Physical Property Charts.

American Lava Corp. has issued reprints of an article **The Electrical Properties of High Frequency Ceramics,** by Dr. Ing. E. Rosenthal, which gives valuable information on the present status of high frequency ceramics in England.*

A discussion of the present uses of calcium metal, including its use as a deoxidizer in ferrous and non-ferrous metals, is contained in a recently issued pamphlet entitled **Calcium Metal Production, A New American Industry,** by A. B. Kinzel, of Union Carbide and Carbon Research Laboratories, Inc.*

Defense Data from the Houghton Line, current issue, contains a timely article on machining aircraft engine parts.*

Two new bulletins have been issued by The Brown Instrument Co. No. 85-17, **Automatic Program Control Systems—Time—Temperature** and No. 23-57 **Control Systems for Forging Furnaces.***

Precision Tube Co. has announced a new catalog covering **Precision Metal Shielded Wire** by its new method of protecting insulated wires enclosed in either seamless aluminum, copper or lead tubing, tinned or untinned.*

Young Radiator Co., Racine, Wis., has issued a booklet, **Plant Facilities For Defense Production,** in which is summarized the research, engineering and manufacturing facilities of the company that are available for defense production. It also describes the background of the company in the manufacture of non-ferrous and sheet metal products for military and civilian uses, consisting principally of heat transfer units. Another important feature is an itemized list of plant equipment.*

* Obtainable through editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia. Please give date of issue in which literature was listed.

Testing Propellers at Hamilton Laboratories

(*Continued from page* 33)

ances due to wear and galling of the centering surfaces of the propeller shaft and cone, due to repeated dismounting; all may contribute to a change in operating characteristics. Eccentricities of no more than 0.0005 in. at the mounting cone may be detected by roughness in certain parts of the airplane structure, it is said. Hence, for research purposes many determinations of vibration are made at levels below the threshold of physical sensation.

For purposes of field study, which is necessary for correlation of work in the laboratory, another special technique has been devised by Hamilton Standard engineers. Appropriate portable equipment has been developed, which can be transported in an ordinary automobile.

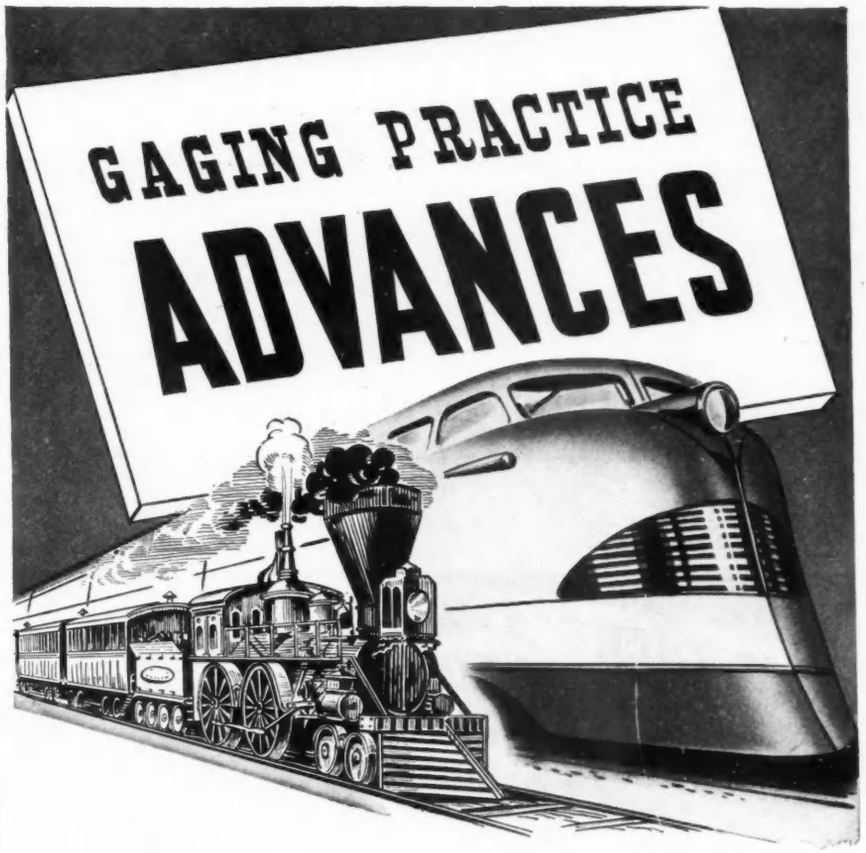
For vibration pickup in field testing use is made of a modification of equipment originally developed to balance turbines, dynamos and other large rotating machinery in operating position. This detecting instrument is established on some part of the plane which is found to vibrate at propeller frequency. Its operation converts vibration frequency into alternating current frequency, affording means for determining amplitude. The phase relationship is simultaneously determined by an alternating current generator driven by the propeller shaft. Technicalities in the theory and functioning of the apparatus are exceedingly involved, especially as they include an intermediate appliance for filtering out of the final determination only the component due to frequency of propeller rotation. The application, however, is highly practical and relatively simple.

Although the technology and most of the special equipment employed at the propeller testing laboratory was originated, and much of it actually built there, as already indicated, Hamilton Standard engineers have collaborated extensively with engineering specialists in other fields.

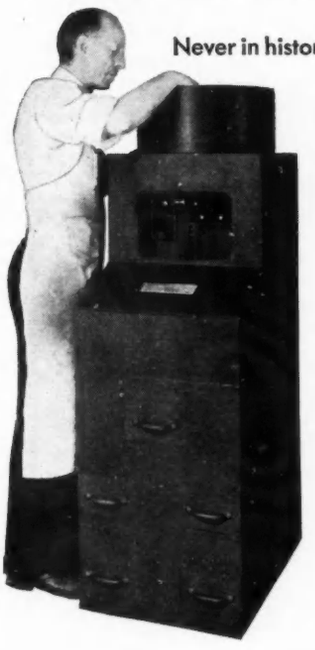
The field balancing apparatus, for instance, is a joint development of Hamilton Standard Propellers and Westinghouse Electric & Mfg. Co.; some of the components having been made by General Electric Co. Development of this set-up was carried out in cooperation with American Airlines, which supplied planes for testing the units during various stages of development. The Dynetic balancing machine was built to specifications by the Gisholt Co., while the pivoted diaphragm was constructed by the Baker Mfg. Co., Evansville, Wis.

To Dissolve GM Sales Corp.

The General Motors Sales Corp. will be dissolved Jan. 1 and its functions and personnel will be absorbed by the General Motors Corp. The move is being made in the interests of expediency.



Locomotives have improved vastly since those ambitious little wood burners struggled across the Union Pacific in the early 70's. The streamliner of today can do far more and do it much faster.



Never in history has progress been made more rapidly in precision gaging than in the last few years. Both standards of accuracy and gaging speed have made spectacular advances. The human equation, such an unpredictable factor just a few years ago, becomes much less troublesome.

Sheffield has its part in this march of gaging progress. It was Sheffield which produced the automatic gage illustrated—also the Electrigage, the Multichek Electrigage, the Precisionaire, the Thread Lead Checking instrument and others. If you are not familiar with what these instruments have accomplished in increased accuracy and faster inspection, write us for the story.

THE SHEFFIELD CORPORATION
Gage Division · DAYTON, OHIO, U.S.A.

SHEFFIELD MASTER GAGEMAKERS

West Coast Airplane Activity

(*Continued from page* 23)

mechanized plants on the Coast. Within the month they have introduced a mechanized final assembly conveyor synchronized with an overhead monorail for the engine drop. Here will be found some of the finest examples of arc welding, resistance welding, and machine shop practice. The whole operation has been developed along the most advanced principles to be found anywhere in passenger car production. This plant, too, has been a pioneer in utilizing women workers for many repetitive tasks and on fine assembly operations for which they are particularly well suited.

North American Aviation at Inglewood, home of the medium bomber, the Mustang single-seater fighter for the RAF, and trainers, employs 13,121 workers at Inglewood. When peak production is attained at Dallas and Kansas City, NAA will employ 12,000 at Dallas and 9000 at Kansas City.

During the past month NAA has initiated a comprehensive program of sub-contracting in which fully 30 per cent of its manufacturing and assembly job is farmed out to approximately 1000 firms. To further this wide-spread activity the company has established a sub-contracting office in Cleveland for the purpose of surveying plant facilities in the East with a view to increasing the current volume of sub-contracting.

Major NAA sub-contractor is Fisher Body whose Memphis Aircraft Division already is making shipments of bomber sections to the Kansas City plant for assembly into B-25 bombers. The Memphis plant is several months ahead of schedule on many of the assemblies. Eight other Fisher Body plants are participating in the bomber program, the Detroit Aircraft Unit being set up to produce 86 smaller bomber parts.

In terms of immediate man-power, Lockheed easily takes the palm with an employment of 50,000 workers—39,000 at Lockheed: 11,000 at Vega. Lockheed is the home of the famous Hudson bomber, the Lightning P-38 Interceptor. Since June, 1940, Lockheed has added over a million square feet of floor space, greatly increasing its personnel.

Down the street in Burbank, the Vega division recently placed in operation its new $8,000,000 plant in which they will build Flying Fortresses; and in which they have already begun manufacture of the Ventura bomber, still a military secret weapon but said to be a more deadly and more powerful ship than the Hudson. Under development is the Unitwin Star-liner still in the experimental stage and the Vega 35 primary-secondary trainer.

The Lockheed operation is replete with mass production techniques, with new processes which should be of interest to both the airplane and automotive industries. One of its unusual features is a drafting room with 1600 draftsmen and engineers under a single ceiling. Vega boasts the world's largest fluorescent lighting installation, containing some 36,524 tubes.

Among the production techniques to be described more in detail later, is the Onsrud high cycle extrusion milling machine, developed for machining the ten long extrusions required for a single P-38 ship. Net result of the introduction of this method is a saving of three and one-half days of production time per ship. Prize exhibit in the press shop is a new Watson-Stillman hydraulic press of 4500 tons capacity.

Another outstanding contribution is the adoption of production line methods in the scientific inspection of aluminum and magnesium castings. This is handled by the X-ray department of the Triplett & Barton Laboratories, located in the Lockheed plant. A battery of four, fully automatic X-ray machines, served by other automatic accessory equipment, makes it possible to complete the radiographic examination of upwards of 20,000 castings per day.

IS THERE A WAY TO GET CARBOLOY TOOLS ON THE JOB FAST UNDER PRESENT CONDITIONS?
Yes!
FALK CORP. SAYS "HERE'S HOW". . . . . .
When Falk Corporation, Milwaukee, needs specially shaped carbide tools fast—it's a matter of minutes—and the job is done!
Take the above job, for example: Machining reduction gear blanks for the main drive of Uncle Sam's destroyers. 14 "specially" designed carbide tools required. Falk "makes" these specials—ready to go—in 135 minutes!
Here's how Falk saves weeks on not just this one job—but on 86% of their carbide tool requirements:
From the 10 styles of Carboloy Standard-Stock Tools—now being manufactured in "mass production quantities" for "universal" use on turning, facing, boring jobs—Falk has selected 9 styles to maintain in stock in their tool room. When specials are needed, Falk adapts the "standards" by quickly grinding the shape desired. Usually no more than a 10-minute job per tool—and as easy to do as the average regrinding of dull tools.
A 12-page booklet tells the story. Free, upon request.
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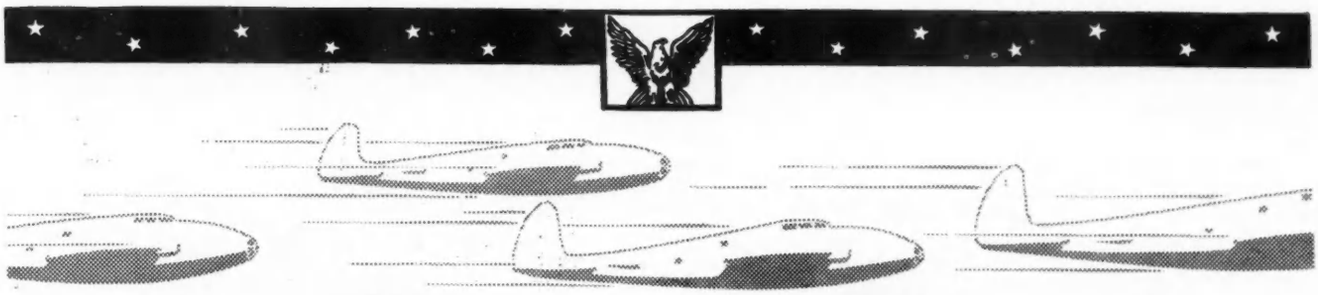
11151 E. 8 MILE STREET • DETROIT, MICHIGAN
Chicago • Cleveland • Los Angeles • Newark • Philadelphia • Pittsburgh • Worcester, Mass.
Canadian Distributor: Canadian General Electric Co., Ltd., Toronto, Canada
STANDARD TOOLS ARE AVAILABLE IN 10 STYLES
STYLE T-1
STYLE T-4 RIGHT HAND (T-7, L. H.)
STYLE T-5 RIGHT HAND (T-9 L. H.)
STYLE T-10 RIGHT HAND (T-11, L. H.)
STYLE T-12
STYLE T-13 RIGHT HAND (T-14, L. H.)
CARBOLOY STANDARD TOOLS & TIPS
Reg. U.S. Pat. Off.
"You ALWAYS Get Standards FASTER Than 'Specials'"
FREE 12-PAGE BOOKLET



16 out of 24

LEADING AIRCRAFT PLANTS MAKING BOMBERS, FIGHTERS AND TRAINERS USE SAFE, DEPENDABLE OAKITE CLEANING MATERIALS AND METHODS

Where thorough, fast cleaning is essential . . . where exacting production requirements must be met . . . where SAFETY to metals is a prime consideration . . . you will find high quality, economical Oakite materials specified and used as they NOW are in the 16 out of 24 leading aircraft plants producing planes for the U. S. and other Governments.

OAKITE AVIATION CLEANER

For preparing aluminum and aluminum alloy parts for anodizing; for pre-cleaning aluminum surfaces for resistance spot-welding, use this APPROVED and STANDARD Oakite material. It is SAFE to surfaces, cleans speedily, produces the results required at low cost.

Write Us Today . . . We Are At Your Service!

Other specially designed and APPROVED Oakite materials also available for use in connection with various cleaning and related operations in aircraft and accessory plants. Inquiries invited . . . we are at your service . . . day or night.

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OAKITE Certified **CLEANING**

MATERIALS . . . METHODS . . . SERVICE

FOR EVERY CLEANING REQUIREMENT

The speed of the process has made it possible to examine every casting and forging that goes into an airplane, thus eliminating any possibility of failure in the air.

Northrup Aircraft of Hawthorne, about 13 miles out of Los Angeles, is gearing up to make its place in this picture. Always a pioneer, John K. Northrup, president, recently startled the country with an announcement of the test flight of the first flying mock-up of Northrup Flying Wing, an all-wing, streamlined, tailless plane which has been abuilding since 1939.

At the present moment, Northrup is engaged in the fabrication of Boeing Flying Fortress sections and is building the complete Vultee Vengeance fighter. An assembly line has been cleared in preparation for the long heralded Northrup night fighter which is now undergoing test flights.

Easily the most dramatic operation from the standpoint of size of plant and physical size of the product is Consolidated Aircraft Corp. of San Diego, nestled in the home of the most important Naval base on the Coast. This is the birthplace of some of the biggest bombers built in this country. Here are built the famous Catalina twin-engine patrol bombers; the B-24D, four-motor Army bomber; the 30-ton PB2Y3, four motor patrol version of the B-24D for the Navy; the Liberator for Great Britain; the new PBY5A, four-motor Navy patrol with retractable landing gear.

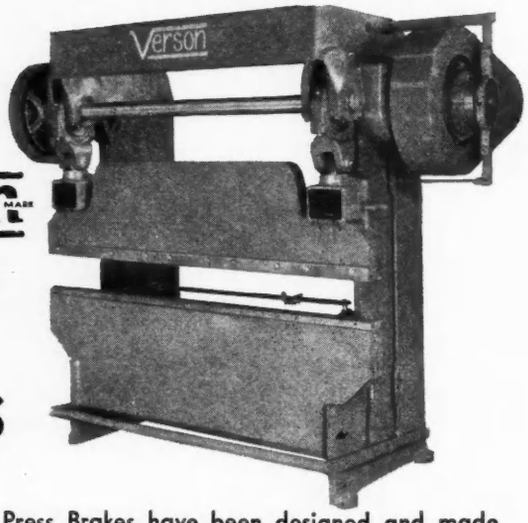
Consolidated is employing about 30,000 workers currently, is adding at the rate of 1000 per week to reach a grand total of 40,000 workers by January. Production operations take place in an area of 5,000,000 sq. ft. of which about 30 per cent is done out-of-doors.

On Oct. 20 Consolidated dedicated its Plant Two, a huge structure set apart for parts production. By concentrating all parts manufacture in this building, Consolidated has been able to clear its main plant almost exclusively for assembly operations.

Despite the size of its huge progeny Consolidated is geared up entirely along mass production lines with mechanized conveyor assembly for the B-24D bomber.

We can close with this observation—when you compare airplane production figures with those for tanks or trucks or motor cars, we must compare them on a man-hour basis. Numerical comparisons simply have no meaning.

TO SPEED PRODUCTION
EFFICIENTLY—ECONOMICALLY



Use Verson JUNIOR PRESS BRAKES

VERSON Junior Press Brakes have been designed and made available to help you effect economies not possible when large expensive machines are used on short heavy jobs or longer light jobs. Only in Verson Junior Press Brakes can you find all of the essential features ordinarily identified with much larger units. Their substantial construction and balanced distribution of steel plate assures accurate bends the full length of the bed and ram. Other features make this a SAFE—DEPENDABLE—EFFICIENT PRODUCTION TOOL.

The seven sizes of Verson Junior Press Brakes meet every requirement demanded of a FAST — POWERFUL — MODERATELY PRICED machine.

Whatever your job may be there is a VERSON Press Brake to handle it FASTER — BETTER and CHEAPER. Ask for our new bulletin, JPB 40, it gives all the facts. Write today.

VERSON ALLSTEEL PRESS CO.
9307 South Kenwood Ave. Chicago, Illinois

Airplane Assemblies in Perspective

(*Continued from page* 28)

for bench assembly or sub-assemblies. They provide a complete list of parts, plus the necessary instructions to complete the jobs ready for storage in their respective bins until they are transported to and issued at their appointed place on the assembly line as called for on the illustrated job tickets.

These drawings, together with the illustrated job tickets, are issued by the Production Planning Department. Materiel Control uses them as a basis for the routing of sub-assemblies, materiel and parts to the assembly line stock rooms, which use them as a guide for the issuing of parts in accordance with the job tickets. Time Standards Department also receives them. The Inspection Department uses them to plan the work of individual inspectors assigned to the assembly line.

Phase 4.—It is expected that changes and slight improvements will be made during the initial period of operation of an assembly line on which new designs are being fabricated. Allowance is made for these adjustments to as great a degree as 30 per cent, as indicated by the curve marked "Changes" on Fig. 3.

J. Walter Drake

J. Walter Drake, 66, president and board chairman of the Hupp Motor Car Co., died Nov. 27 at his home near Detroit after a long illness. He was one of the founders of the Hupp company in 1908 and assistant secretary of commerce from 1923 to 1927.

FREE DU PONT BOOKLET

TELLS HOW "LUCITE" IS USED ON TRANSPARENT AIRPLANE ENCLOSURES

HERE in handy form to fit the pocket are data you've wanted on the advantages of strong, cystal-clear, lightweight, weather-resistant Du Pont "Lucite" for transparent airplane enclosures. This new booklet provides specific advice on machining and forming cast "Lucite" methyl methacrylate resin sheeting for airplanes. You will find it helpful in designing enclosures for your new planes. Useful information is included on:

SAWING	TURNING	BLANKING
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Drawings, dimensions and descriptions of actual parts are given for 16 enclosures made of "Lucite." These include sliding cockpit canopies, windows, portholes, escape doors, landing light covers, and others.

Write today for your free copies of "16 Solutions to Your Transparent Enclosure Problems with Du Pont 'Lucite'." Just fill out and mail coupon.

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"LUCITE" for Automobiles for Airplanes
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E. I. du Pont de Nemours & Co. (Inc.)
Plastics Department, Arlington, N. J.

Send, without charge, —— copies of your new booklet, "16 Solutions to Your Transparent Enclosure Problems with Du Pont 'Lucite'."

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*City & State*_____

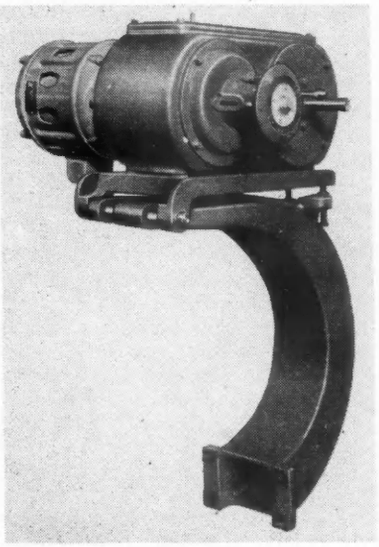
MEN and MACHINES

(*Continued from page 37*)

This machine can be adapted to lapping, polishing, buffing, burring, and filing. Equipped with a ½-hp. motor, it is furnished to run on either single- or three-phase A-C current.

REEVES PULLEY CO., Columbus, Ind., now offers the Reeves Machine Tool Drive, a motorized variable-speed drive for machine tools which is designed to eliminate the necessity of building a special support in order to mount the unit. The support bracket is available in two sizes. The drive uses either the Reeves Vari-Speed Motodrive, as shown in the illustration, or the countershaft-type Vari-Speed Motor Pulley. Any speed within the limits of the machine may be obtained by turning a handwheel.

With the Motodrive, capacities from ¼ to 10 hp., and speed ratios from 2:1 through 6:1 are available. A single-reduction gear reducer can be furnished. Using the Vari-Speed Motor Pulley, capacities range from ¾ to 7½ hp., and cover speed ranges of either 2¾:1 or 3:1 ratio. Both the Motodrive and Vari-Speed Motor Pulley can be supplied for either constant torque or constant horsepower applications.

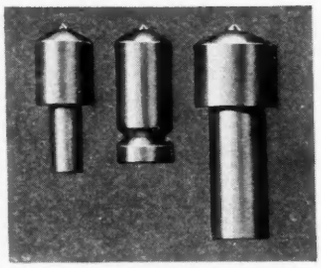


Reeves Machine Tool Drive.

TODAY'S PROBLEM: Production!

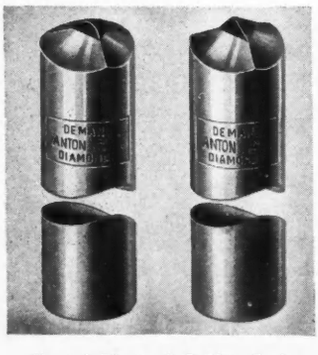
TOMORROW'S PROBLEM: Competition!

Solve BOTH with ASCO DIAMOND TOOLS



Landis Nib, Norton Nib, Cincinnati Nib for truing and shaping emery wheels

Manufacturers who now use "Asco" Diamond Tools to increase defense production, will be in a favorable position to meet keen post-war competition. The unequalled hardness, durability and cutting qualities of diamonds, so vital to today's need for faster production, will provide the savings that will keep many a manufacturer "out of the red" when business goes back on a peace-time basis. "Asco" Diamond Tools are unsurpassed for turning, boring, milling and truing on toughest metals, alloys and abrasive materials. They permit precision cutting at higher speeds, maintaining close tolerances for much longer periods. They impart a finish so smooth that further grinding and polishing are often unnecessary. The name "Asco" is your assurance of dependable quality, backed by Anton Smit & Co., Inc., for over thirty years specialists in industrial diamonds for every need. Send blueprints for quotations on special shaped tools. Write for illustrated folder and prices.



Shaped Diamond Cutting Tools for turning, boring, facing

ANTON SMIT & CO., INC.

LEONARD J. A. SMIT, Managing Director

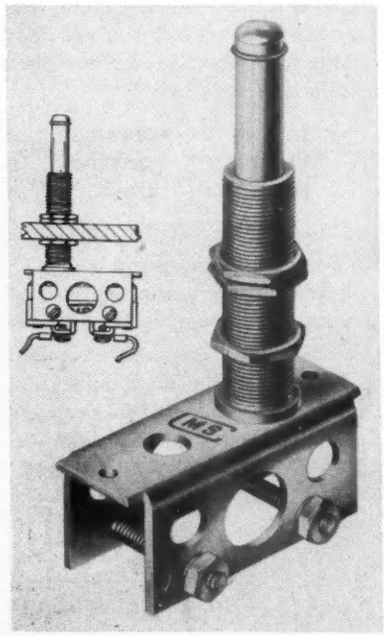
24 STATE STREET - - NEW YORK, N. Y.

TELEPHONE: BOWLING GREEN 9-0616

IMPORTERS OF INDUSTRIAL DIAMONDS—BORTZ, CARBONS AND BALLAS.

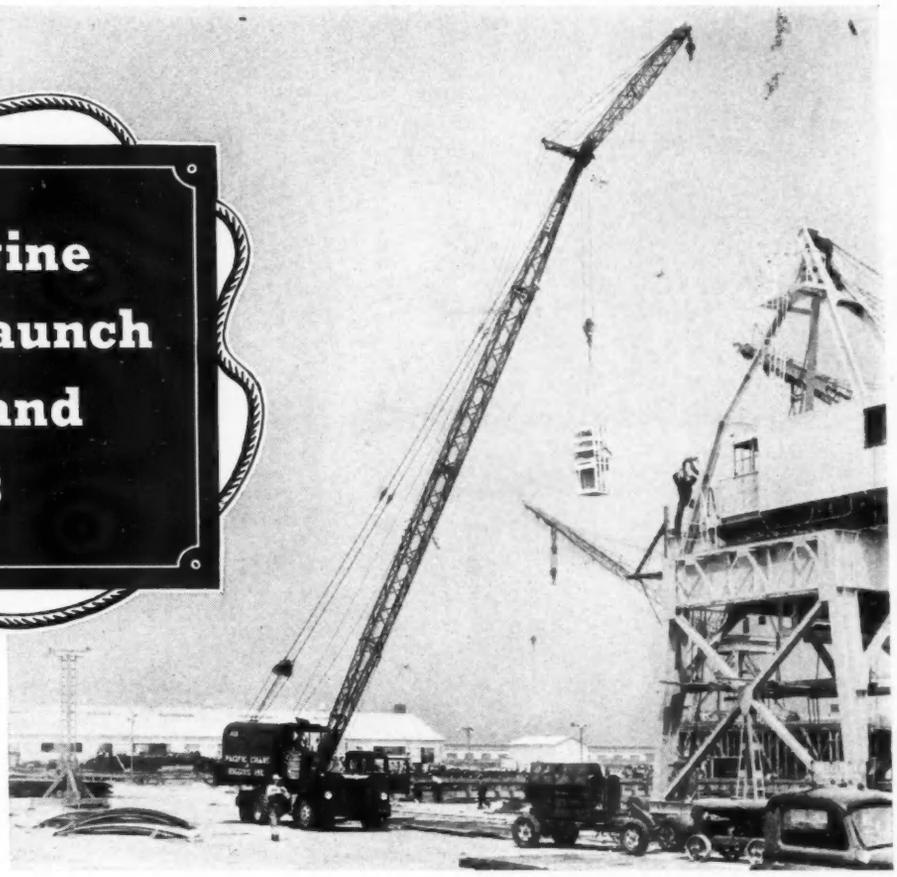
MANUFACTURERS OF ALL KINDS OF DIAMOND TOOLS.

Micro-Switch Actuator



New Micro Switch Actuator Type M, designed primarily for aircraft panel mounting by the Micro Switch Corp., Freeport, Ill.

The Engine that will launch a thousand ships



"The face that launched a thousand ships" did the job for the ancient Greeks. Today ships are still the first line of defense—but it takes shipyards to build 'em. And Waukesha Engines . . .

Here we see Pacific Crane & Rigging, Inc. of Los Angeles moving materials on the California Shipbuilding Corp. defense projects with a Waukesha-powered Lorain Moto-Crane.

Why are so many contractors . . . on defense jobs everywhere . . . using Waukesha-powered machinery?

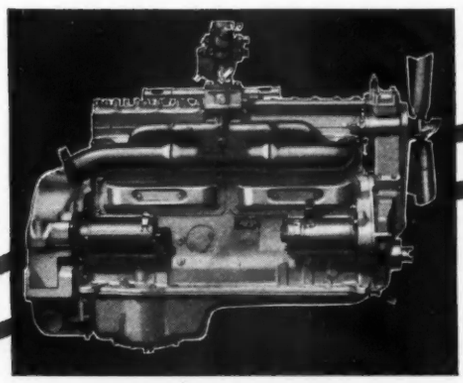
Because you can *push* Waukesha-powered equipment . . . *24 hours a day!* And still get full power capacity, smooth, grief-free operation . . . with both fuel and lubricant economy . . . and no increase in maintenance.

Waukeshas are consistently dependable. That's why Waukesha Engines have been the standard power for the Ingersoll-Rand engine driven portable compressor . . . for 27 straight years.

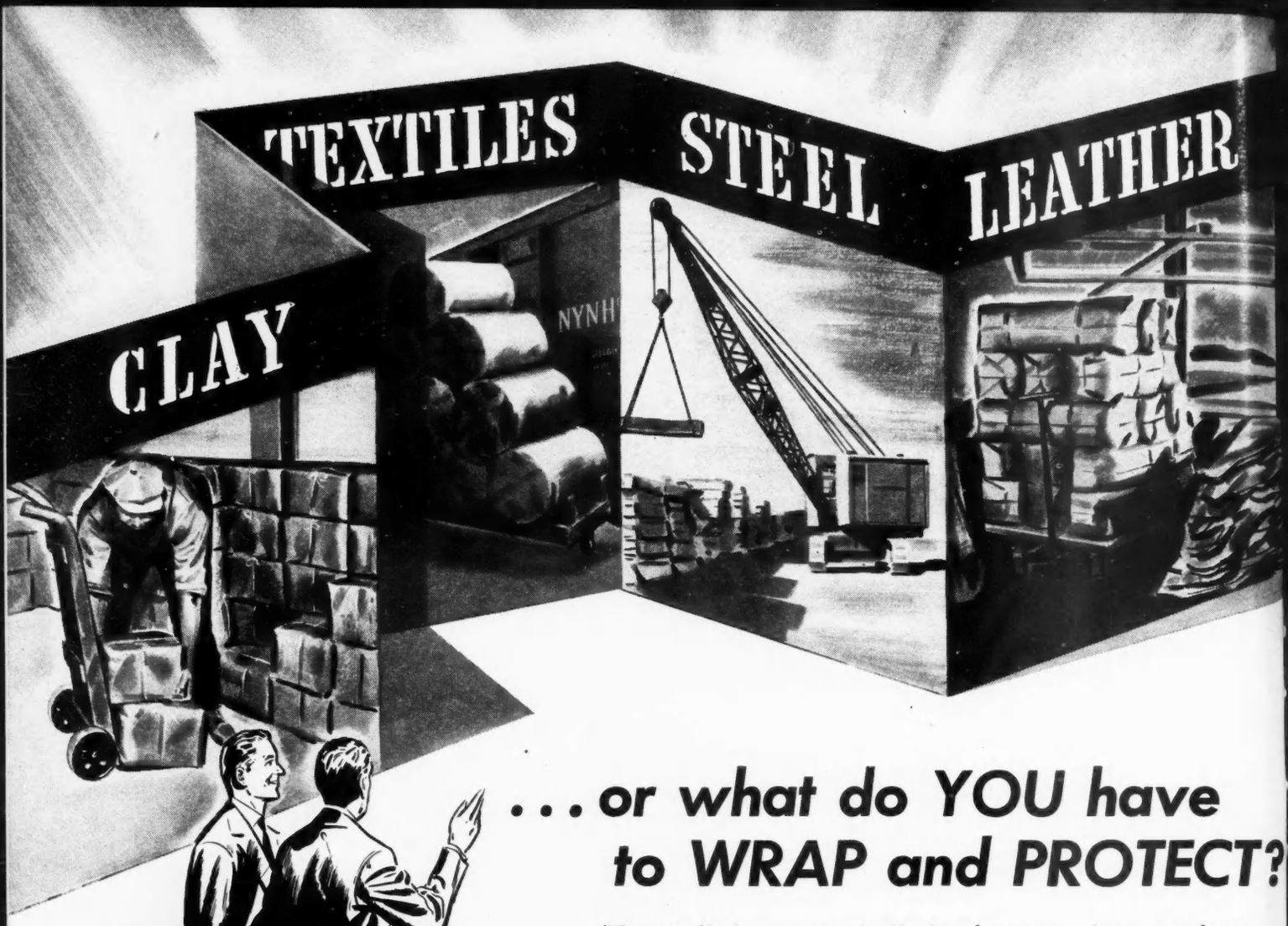
That's why Waukesha Gasoline and Oil Engines are being used on every kind of unit of standard contracting equipment requiring from 5 hp. to over 300 hp. as well as for countless other industrial, stationary and automotive applications. Get the details — Bulletin 1079.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK TULSA LOS ANGELES

MORE POWER FOR DEFENSE



WAUKESHA ENGINES



. . . or what do YOU have to WRAP and PROTECT?

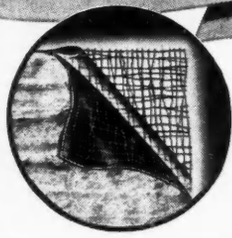
There's little or no similarity between these products. Each presents an entirely different problem in protection, during inside and outside storage as well as in transit — but FIBREEN serves them all — and hundreds of others too, large and small, in all types of industry.

Perhaps it can serve you. In factory after factory FIBREEN is doing a "better" job . . . speeding up the work in shipping rooms, reducing costs, and guarding against claims for damaged goods.

FIBREEN is amazingly strong and tough. It's waterproof, dirtproof, pliable and clean . . . an ideal wrapping and protective material, available everywhere at low cost.

Let us send you a supply of FIBREEN without cost or obligation, for you to try. Let The Sisalkraft Co. shipping experts offer recommendations. Simply write, explaining what you ship and how you now pack it.

FIBREEN

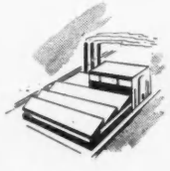


FIBREEN is 6 ply: TWO layers of strong kraft, reenforced with TWO layers of crossed sisal fibers embedded in TWO layers of special asphalt — all combined under heat and pressure. FIBREEN is pliable and clean — will not scuff—stands an astonishing amount of abuse and exposure. It is used either as a wrapping or a lining material.

Soak it—twist it—try to tear it!

Only when you get a sample in your own hands can you realize that a *paper* can be so strong—so tough—and impervious to moisture. Write for sample.

FIBREEN is a product of The Sisalkraft Co.—also manufacturers of Sisalkraft, Sisal-X, Sisal-Tape and Copper-Armored Sisalkraft.



THE SISALKRAFT CO.
205 W. WACKER DRIVE · CHICAGO, ILL.
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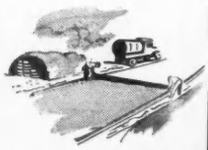

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MUSKEGON MPR PISTON RINGS

● Piston Ring performance depends directly on design and then—faithful production.

Here at Muskegon the faithfulness of the finished product is made certain by *rigid inspection* of both materials and workmanship.

The most modern technical apparatus in the hands of experienced engineers assures Muskegon users of *high* and *consistent* performance.

Let us consult with you on problems relating to Piston Rings.

MUSKEGON PISTON RING CO.
Muskegon, Michigan
PLANTS AT MUSKEGON AND SPARTA

MUSKEGON
Piston Rings

FAMOUS LIFE LINES

1 **THE PANAMA CANAL,** life line of the great two ocean navy we are building, can carry the entire fleet from one ocean to the other in forty-eight hours. Here the aircraft carrier, U.S.S. Lexington, is passing through.

Acme

2 **THIS MEDIUM TANK'S** life lines —its oil lines, fuel lines, conduits —are made from various types of Bundy tubing, standard for these uses on most of Uncle Sam's mechanized and motorized equipment.

Wide World

WHEN MAKERS of tanks and half-tracs and "jeeps" and "beeps"—or any of the dozens of other types of motorized equipment for the army—think of tubing, they naturally think of Bundy.

For the automotive industry, from which these great new defense industries sprang, has long recognized Bundy tubing as standard for carrying lubricants and fuel or for transmitting hydraulic pressures. Among makers of refrigeration equipment, too, and of machine tools, Bundy tubing is widely used because of its strength, its ductility, and its resistance to vibration fatigue.

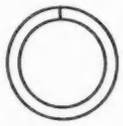
Other Bundy tubing is going into primer lines for aircraft and marine engines, into telescopic radio aerials, into every type of refrigerating and gas heating appliance used by the army and in defense housing, and into dozens of more prosaic but equally important mechanical uses.

If you use tubing within the range of Bundy's sizes, you should hear Bundy's complete story. Bundy tubing is furnished in commercial lengths, or in completely fabricated parts, bent to shape and with necessary fittings, all ready to assemble into the finished product. Bundy Tubing Co., Detroit.

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

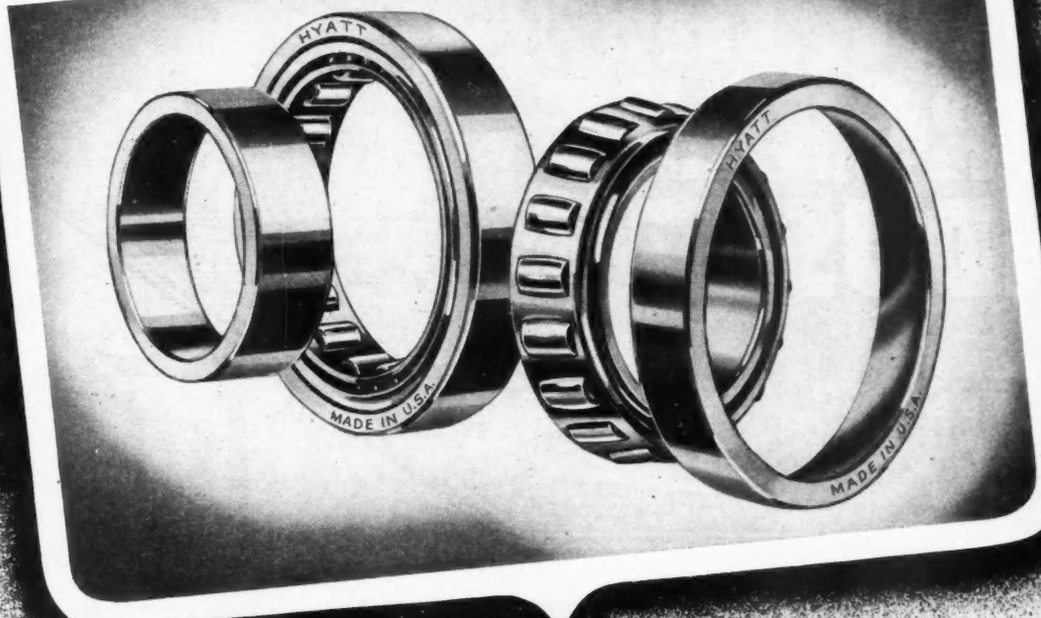
BUNDYWELD double-walled steel tubing, hydrogen-brazed, copper-coated inside and outside. From Capillary sizes up to and including $\frac{1}{16}$" O. D. This double-walled type is also available in steel, tin-coated on the outside, and in Monel.



BUNDY ELECTRIC WELD steel tubing. Single-walled — butt welded — annealed. Also furnished tin-coated outside if desired. Available in sizes up to and including $\frac{5}{8}$" O. D.

BUNDY "TRIPLE-PURPOSE" MONEL tubing. Double-walled, rolled from two strips, joints opposite, welded into a solid wall. Available in all Monel, Monel inside —steel outside, and Monel outside—steel inside. Sizes up to and including $\frac{5}{8}$" O. D.

KEEP THEM GOING WITH HYATTS

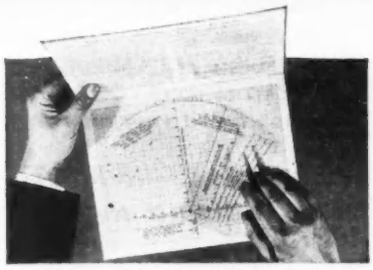


NO MATTER WHAT THE APPLICATION

In addition to meeting demands for regular 1942 automotive bearing applications, Hyatts are filling the industry's need for bearings assigned to mechanized defense equipment.

Also, Hyatt Roller Bearings are helping to free, from bearing wear and care, the machinery in your plants which has been called upon to produce this defense equipment.

As this proves once more, today and always, where the loads are heavy and the going tough you can depend on Hyatt Roller Bearings for any application.



FREE TO MACHINE DESIGNERS

HYATT GEAR THRUST CALCULATOR —valuable timesaver for designers and engineers. Request in writing on your company letterhead — address Engineering Department, Hyatt Bearings Division, General Motors Sales Corporation, Detroit, Mich.

HYATT

ROLLER BEARINGS

QUIET

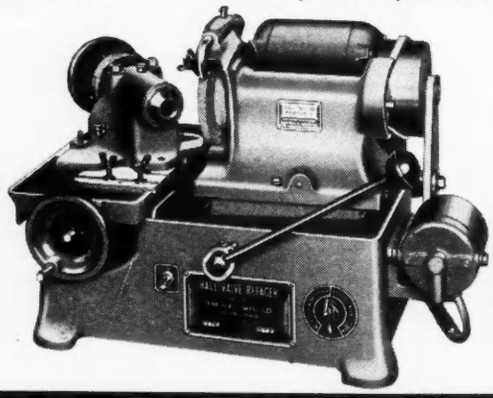
HALL KEEPS PACE WITH THE AIRCRAFT INDUSTRY

Because airplane engine manufacturers use them for production and army and navy air depots, transport companies and privately owned shops all over the world use them for restoring original factory precision and finish, production of HALL ECCENTRIC Valve Seat Grinders has naturally grown with plane production.

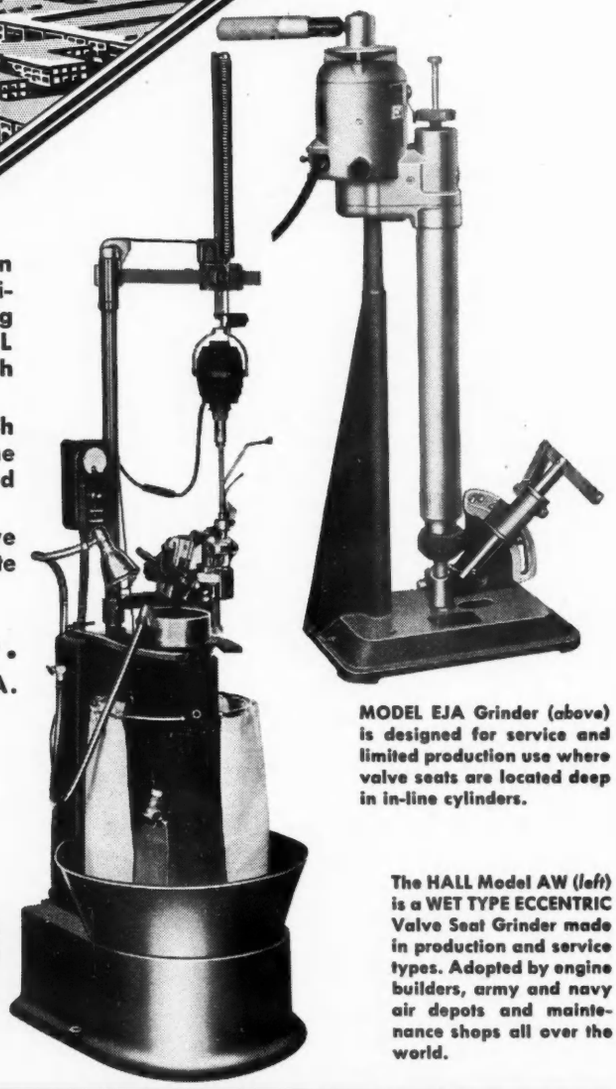
In development, too, HALL engineering has kept pace with aviation engineering. That's the one reason why airplane engine performance has been improved, valve life multiplied and production and overhaul speeded up.

HALL builds or CAN build ECCENTRIC type precision valve seat grinders to meet YOUR requirement. Catalog and complete information await your request.

THE HALL MANUFACTURING CO.
1626 WOODLAND AVE. TOLEDO, OHIO, U. S. A.



Right: **HALL WET TYPE Aero Valve Refacer with dual motors, rheostat control and a patented chuck that won't brinnell the valve stem. Wet grinding prevents head distortion and surface burning.**



MODEL EJA Grinder (above) is designed for service and limited production use where valve seats are located deep in in-line cylinders.

The HALL Model AW (*left*) is a WET TYPE ECCENTRIC Valve Seat Grinder made in production and service types. Adopted by engine builders, army and navy air depots and maintenance shops all over the world.

HALL ECCENTRIC SEAT GRINDERS

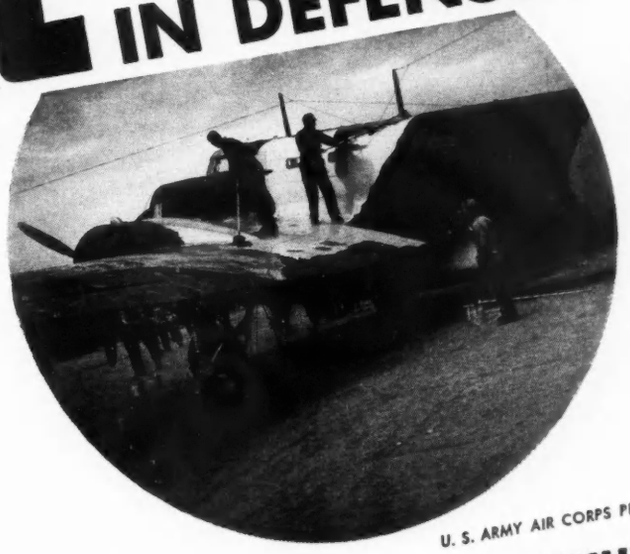
NO. 3 OF A SERIES

ZINC IN DEFENSE-

PAINT SERVES DEFENSE IN:

- Aircraft
- Camouflaging
- Cantonments
- Combat Cars
- Guns
- Industrial Plants
- Marine Equipment
- Pontoon Bridges
- Scout Cars
- Shells
- Troop Carriers—

And In Many Other Ways



U. S. ARMY AIR CORPS PHOTO

PAINT
DIE CASTING
CERAMICS
BRASS
METAL SPRAYING
GALVANIZING
PHARMACEUTICALS
NICKEL SILVER
NO. 1 HULL PLATES
NO. 2 RUBBER

THE ELEMENTS ARE ALSO DESTRUCTIVE!

The primary requirement of many defense items is the ability to withstand the destructive forces of war. But there are other forms of attack to be reckoned with as well—rust, chemical corrosion, and the destructive forces of the elements on land and sea. The answer to these problems is paint. Uncle Sam is faced with the biggest painting job in the history of the country—a job in which zinc pigments are playing a vital part.

No man can estimate the amount of zinc pigments needed to complete this job, but the final figure will be a staggering one. The camouflage painting, shown above, is only a small part of the story. Everything from shells to ships, from cannon to cantonments has already been covered by hundreds of exacting Government paint specifications—requiring quantities of zinc sulfide, zinc oxide, lithopone, zinc dust and zinc chromate.

Listed above are typical uses for paint coatings in defense. Zinc pigments are doing the same job in these defense paints as they have been doing in the paint industry year in and year out—protecting property and improving sanitation, too, when that is a factor. It is the increased demand for each of the zinc consuming products required in the Defense Program which is making it difficult for non-defense users to obtain all of the zinc they would like to use. This is part of the price that must be paid for national security.

PAINT PROTECTS AMERICA
ZINC PROTECTS PAINT

THE NEW JERSEY ZINC COMPANY

MANUFACTURERS OF THE FAMOUS HORSE HEAD ZINC PRODUCTS

Kelly

THE "GASOLINE AGE" IS JUST BEGINNING

WE STAND on the threshold of the real age of gasoline power.

Despite the great progress which has been made thus far in the development of automotive fuels and engines, only a fraction of the energy in gasoline is being utilized. The greatest significance of the developments which have been made to date lies in their value as part of the foundation for the far greater progress of the future.

In the establishment of this foundation for future progress, not only the actual technical results but also the manner of their achievement are of great importance. Fuel problems and engine problems once were regarded as things apart, and they were handled accordingly. Today, it is realized that the entire automotive unit with its fuel and lubricants must be considered together. The result is that research on the development of fuels, engines and lubricants is coordinated to be of maximum benefit to automotive transportation as a whole.

From the standpoint of the engine builder this coordinated development involves exploring the application of supercharging and super-compression ratios to engines, for utilizing the high octane fuels which will be produced by combining the products of new refining processes with anti-knock additives. An essential part of the study of super-compression and supercharging is the investigation of related engine design changes which may be necessary.

Because of the close relation of engine and fuel characteristics and engine operating conditions, design changes in such vehicle parts as inlet manifolds or transmissions may have important effects on fuel utilization, and they should be considered from this standpoint.

We of the Ethyl Gasoline Corporation have built up a wide experience in laboratory and field studies in which fuels and engines must be considered together, and our facilities are especially designed for such work. Our research and service workers welcome opportunities to cooperate in extending the usefulness and efficiency of automotive transportation through the mutual development of fuels and engines, thus expanding the benefits of the "gasoline age."

ETHYL GASOLINE CORPORATION

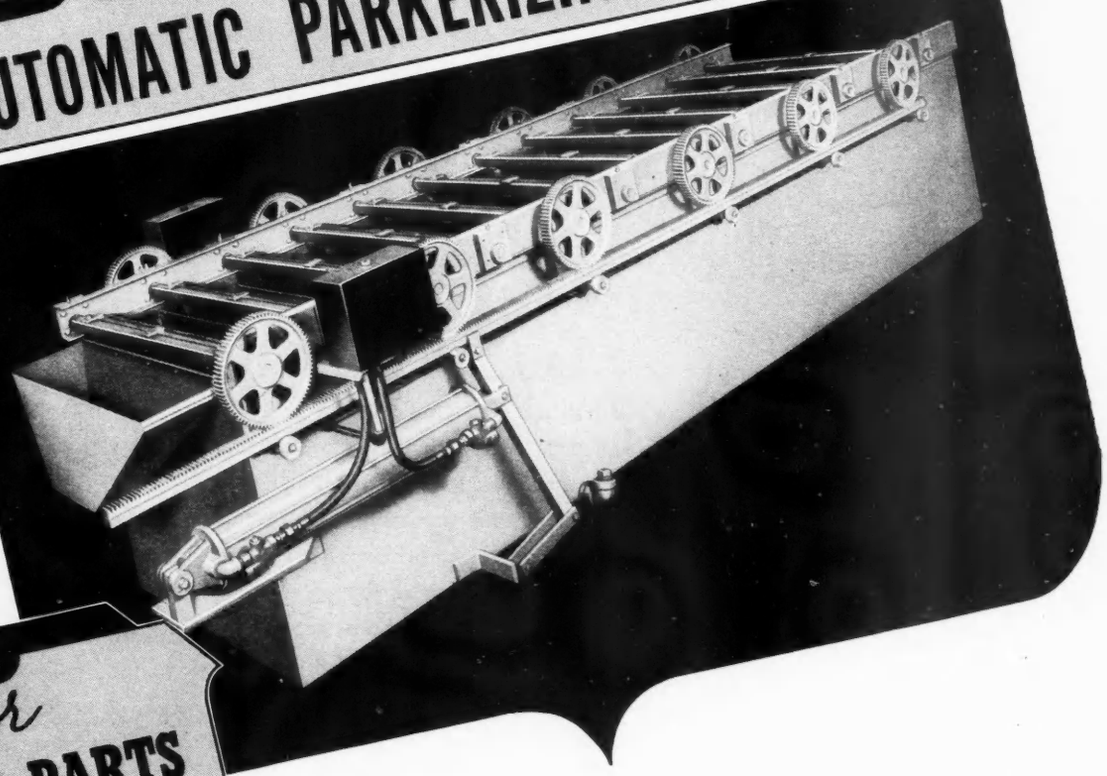
Chrysler Building, New York, N. Y.

WITH ETHYL (TRADE MARK) REG. U.S. PATENT OFF. BRAND OF ANTI-KNOCK COMPOUND ETHYL GASOLINE CORPORATION

REG. TRADE MARK

UDYLITE

AUTOMATIC PARKERIZING MACHINE



For

SMALL PARTS

- ★ Garand Clips
- ★ 20 mm. Links
- ★ 30 and 50 Calibre Machine Gun Links
- ★ Miscellaneous Machine Gun Parts

● The Udylite Automatic Parkerizing Machine will handle large quantities of small parts continuously through the entire parkerizing cycle, including all cleaning, rinsing, oiling, staining and drying operations. The machine is fully automatic. No manual operation is required. It can be equipped with automatic loading and unloading devices.

Parts are transferred from tank to tank in complete batches. Loads cannot become mixed in the machine.

Machine can be air or hydraulically operated. It is entirely self contained, compact, sturdy—constructed for low maintenance costs. Processing time can be varied to requirements. If you have a national defense contract which calls for parkerized finish on small parts this is the machine you should have. Our engineers can quickly estimate your requirements. We are in a position to make quick delivery.

THE UDYLITE CORPORATION

1651 E. Grand Blvd., Detroit, Mich.

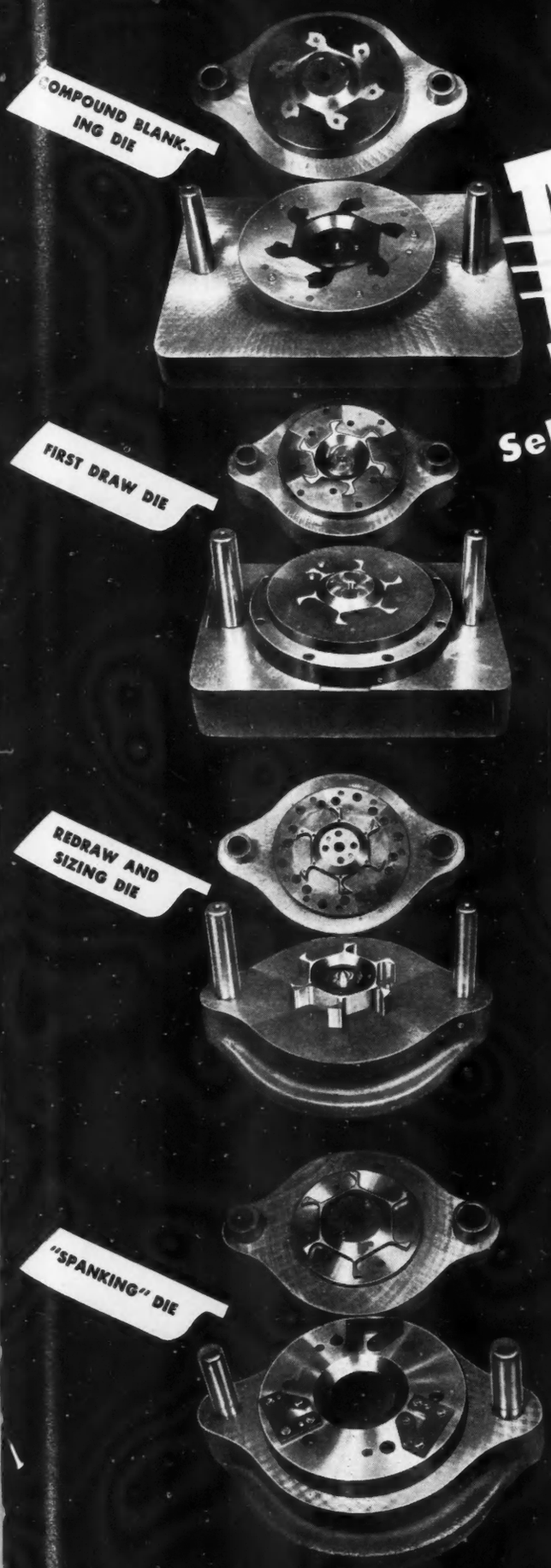
New York
60 E. 42nd Street

Chicago
1943 Walnut Street

Cleveland
3756 Carnegie Ave.

AIR HARD

Selected* for this complete set of blanking and forming dies



*By BOYAR-SCHULTZ CORP.
Chicago, Ill.

...because AIR HARD holds shape in heat treatment and insures increased production on-the-job!

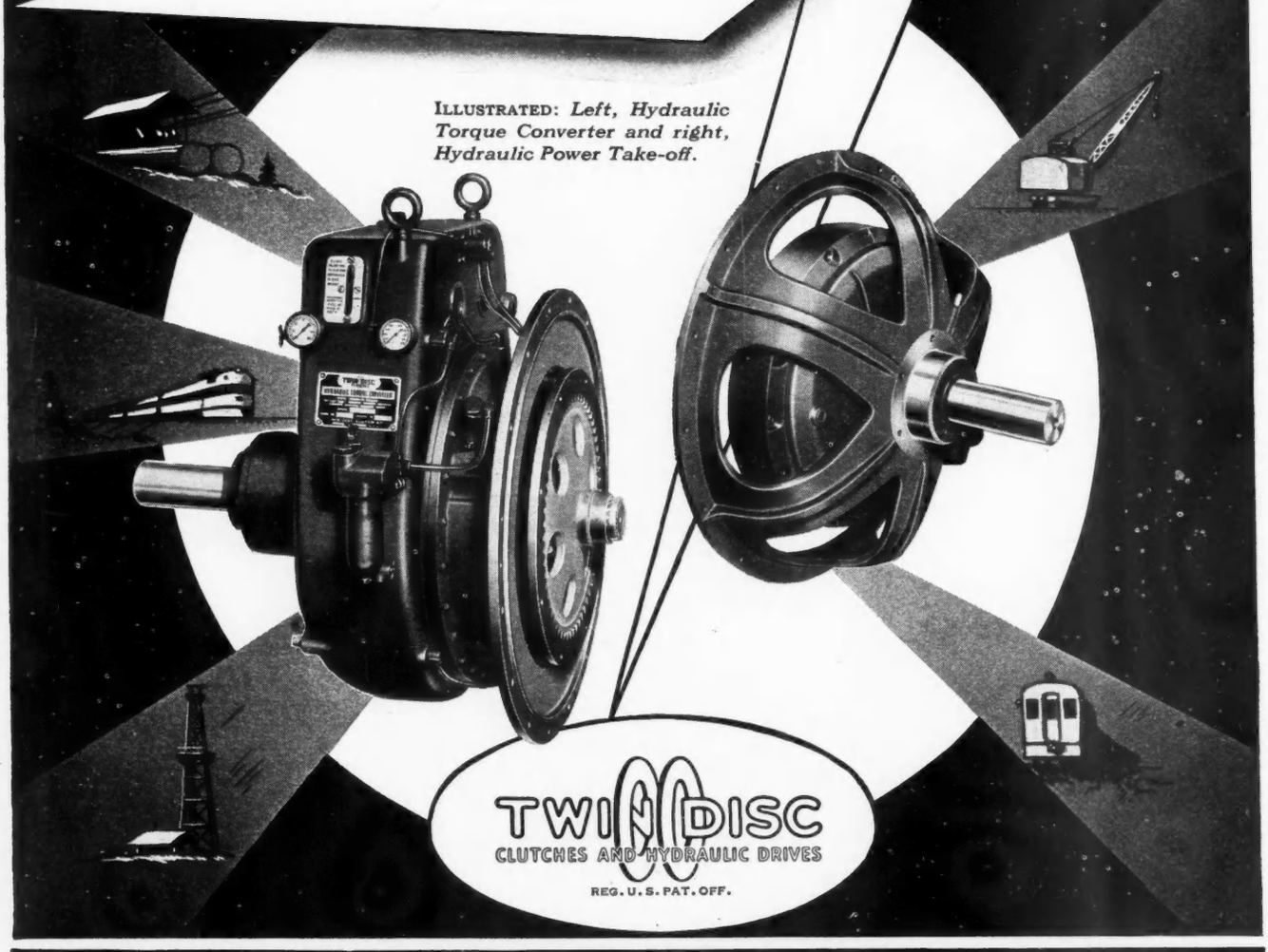
From rough blank and center emboss (not shown) through the rest of five die operations on a special piece part, AIR HARD is *there* 100%! Deep-hardening, non-deforming, meeting your top steel performance requirements for intricate dies.

"TOPS IN TOOL STEELS"

Vanadium-Alloys STEEL CO. LATROBE, PA.

They all point to HYDRAULIC DRIVES

Any job on which the use of high speed internal combustion engines demands the repeated starting of heavy loads . . . or an excessive amount of gear shifting to accommodate varying load conditions is a typical job for the Twin Disc Hydraulic Drive. Case studies on hundreds of working examples, in a wide variety of applications, are now available to any engineer who is planning to take advantage of the definite trend to hydraulic drives—either a Hydraulic Torque Converter or a Hydraulic Clutch. Ask for Bulletin 132 or write the Hydraulic Department for definite recommendations.

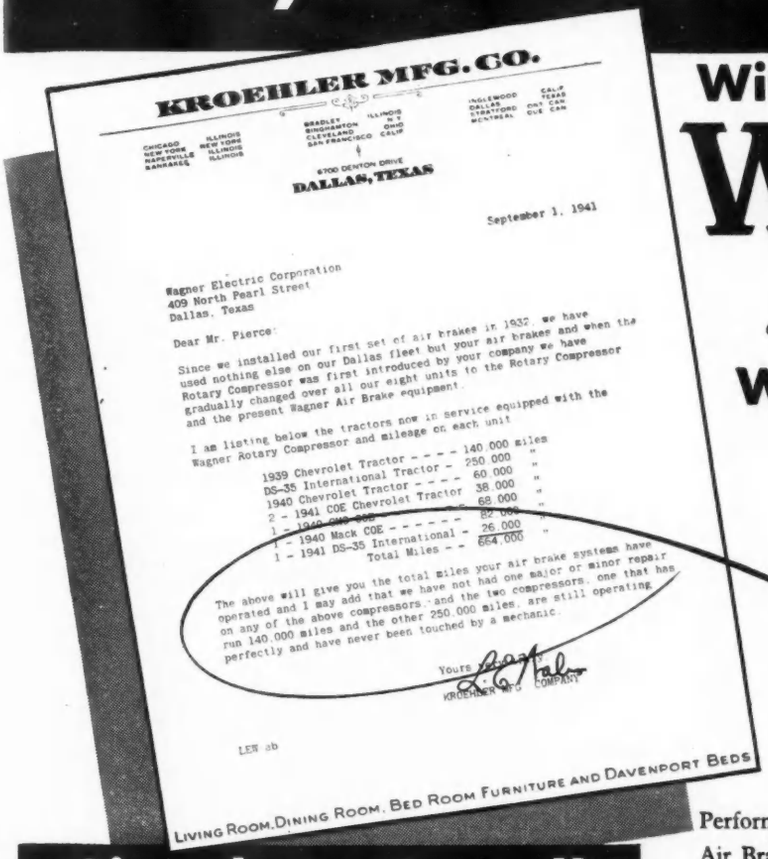


ILLUSTRATED: *Left, Hydraulic Torque Converter and right, Hydraulic Power Take-off.*

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

TWIN DISC CLUTCH COMPANY, 1344 RACINE STREET, RACINE, WISCONSIN

664,000 Safety Miles



KROEHLER MFG. CO.

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INGLEWOOD CALIF.
DALLAS TEXAS
STRATFORD ONT. CAN.
MONTREAL QUE. CAN.

6700 DENTON DRIVE
DALLAS, TEXAS

September 1, 1941

Wagner Electric Corporation
409 North Pearl Street
Dallas, Texas

Dear Mr. Pierce:

Since we installed our first set of air brakes in 1932 we have used nothing else on our Dallas fleet but your air brakes and when the Rotary Compressor was first introduced by your company we have gradually changed over all our eight units to the Rotary Compressor and the present Wagner Air Brake equipment.

I am listing below the tractors now in service equipped with the Wagner Rotary Compressor and mileage on each unit

1939 Chevrolet Tractor	140,000	miles
DS-35 International Tractor	250,000	"
1940 Chevrolet Tractor	60,000	"
2 - 1941 COE Chevrolet Tractor	38,000	"
1 - [illegible]	68,000	"
1 - 1940 Mack COE	82,000	"
1 - 1941 DS-35 International	26,000	"
Total Miles	664,000	"

The above will give you the total miles your air brake systems have operated and I may add that we have not had one major or minor repair on any of the above compressors, and the two compressors, one that has run 140,000 miles and the other 250,000 miles, are still operating perfectly and have never been touched by a mechanic.

Yours
L. E. Hale
KROEHLER MFG. COMPANY

LEH ab

LIVING ROOM, DINING ROOM, BED ROOM FURNITURE AND DAVENPORT BEDS

With WAGNER Air Brakes

Without any repairs

"We have not had one major or minor repair on any of the above compressors, and the two compressors, one that has run 140,000 miles and the other 250,000 miles, are still operating perfectly and have never been touched by a mechanic."

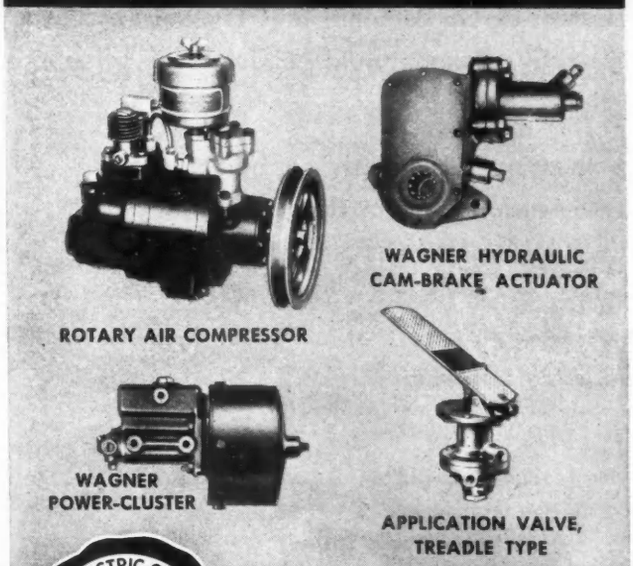
Performance of this kind is not unusual when Wagner Air Brakes — the air brakes with the rotary compressor — are on the job.

Thousands of truck owners and fleet operators have already installed Wagner air brakes on their rolling equipment and this increasing popularity makes Wagner air brakes an extra profit item that manufacturers and dealers should not overlook.

There are three Wagner Air Brake Systems: (1) The Wagner Hydrair Brake, the system that combines air power with hydraulic actuation; for commercial vehicles equipped with cam brakes, (2) the Wagner Air-Hydraulic Brake for commercial vehicles equipped with internal hydraulic brakes, and (3) the Wagner Straight-Air Brake, for commercial vehicles equipped with straight-air-actuated cam brakes.

Simple to Install

All parts that make up the Wagner air brake systems are simple in design and easy to install.



ROTARY AIR COMPRESSOR

WAGNER HYDRAULIC CAM-BRAKE ACTUATOR

WAGNER POWER-CLUSTER

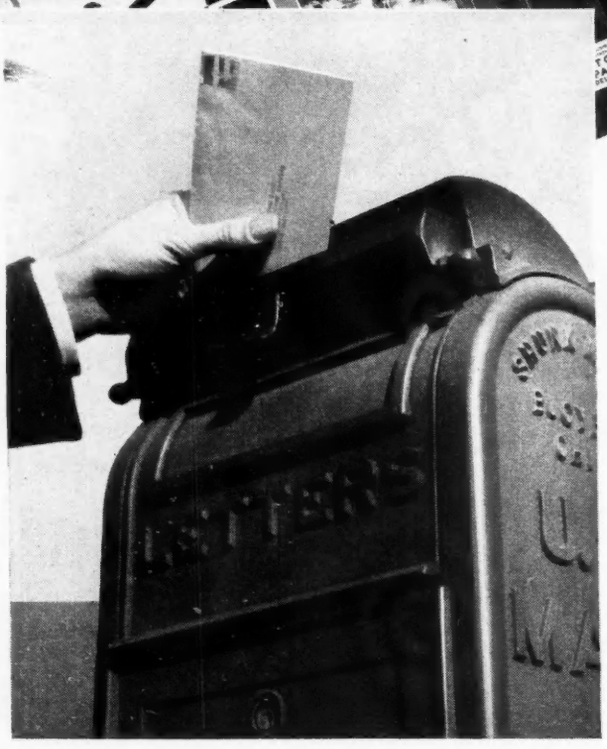
APPLICATION VALVE, TREADLE TYPE

Write for new Air Brake Booklet KU-50. It explains and illustrates the complete line of Wagner Air Brakes.

K41-9

WAGNER ELECTRIC CORPORATION 50TH ANNIVERSARY 1891 • 1941 ST. LOUIS, MO.

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.
BRAKES MOTORS TRANSFORMERS FANS



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$259,000

ANNUALLY

for AUTOMOTIVE PUBLICATIONS and SERVICES

Subscribers to Chilton Automotive Publications and Services pay more than a quarter of a million dollars every year, to read and refer to AUTOMOTIVE INDUSTRIES, MOTOR AGE, the CHILTON FLAT RATE & SERVICE MANUAL, the CHILTON BODY & FRAME MANUAL, and COMMERCIAL CAR JOURNAL.

That averages $3.00 per reader, excluding the truck fleet distribution of Commercial Car Journal and Chilton Automotive Buyer's Guide circulation, which is controlled.

We mention this largely to bring to your attention the fact that first of all CHILTON Company is in the publishing business, as compared with some publishers who may first of all be in the ***advertising*** business.

Please NOTE: Chilton Flat Rate & Service Manual and Chilton Body & Frame Manual do not carry advertising.

CHILTON AUTOMOTIVE PUBLICATIONS
and Services
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THEIR TOP-NOTCH QUALITY

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Fuel Pumps
Controllable Pitch Propeller Governors
Ammunition Rounds Counters
Windshield Wipers

REMOTE CONTROL

Radio Receivers
Beacon Receivers
Compass Loops
Antenna Loops
Antenna Reels
Heating Registers
Tab Controls
Turn Bank Indicators
Prestone Shutters

AUTOMOTIVE

POWER DRIVE

Taximeters
Truck Recorders
Windshield Wipers
Speedometers
Service Car Cranes
Portable Tools
Automatic Carburetors
Convertible Top Mechanisms

REMOTE CONTROL

Auto Radios—panel and underseat
Radio Antennas
Clock Setting
Trip Mileage Reset
Choke and Needle Valve
Engine Governors
Search Light
Gear Shift
Heaters
Air Conditioning

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are being turned out today in unprecedented volume to meet the greatly expanded demands of the Aircraft Industry. And these demands are being met without the slightest deviation from the rigid standards of quality that have always distinguished S. S. WHITE Flexible Shafts. Therefore, every shaft that leaves the factory today can be counted on for the same *efficient performance* and *unfailing reliability* that long ago established S. S. WHITE Flexible Shafts as *first choice* for aircraft applications.

DATA FOR ENGINEERS

Latest data about S. S. WHITE Flexible Shafts, Flexible Casings and End Fittings are contained in the following bulletins:

BULLETIN 839
Flexible Shaft Combinations for Aircraft.

BULLETIN 38
Flexible Shafts for Remote Control.

BULLETIN 1238
Flexible Shafts for Power Drives.

COPIES OF THESE BULLETINS WILL BE MAILED ON REQUEST.

ENGINEERING COOPERATION

in applying flexible shafts for the established uses listed at the left, or for working out new applications, is at your service. Write us.

S. S. WHITE

The S. S. White Dental Mfg. Co.
INDUSTRIAL DIVISION
Department A, 10 East 40th St., New York, N. Y.

FLEXIBLE SHAFTS for POWER DRIVES, REMOTE CONTROL and COUPLING

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PRECISION COLD ROLLED STRIP STEEL
HERE . . .
. . RESULTS IN TOP PRODUCTION EFFICIENCY AND MORE FINISHED PARTS PER HUNDRED POUNDS HERE

Coil after Coil of duplicated accuracy speeds Defense Production

With the demand for new defense products and parts has come numerous production problems for the participating industries. And the right cold rolled strip steel for the job is of vital importance—steel that provides trouble-free fabrication, accuracy to specifications and uniformity of physical properties, each and every shipment. CMP strip fulfills those rigid requirements and can always be counted on for "extras" too—rolling to extremely close tolerances that assure maximum feet per pound. That's the way many manufacturers are speeding output and gaining increased number of parts per pound—repeatedly specifying CMP.

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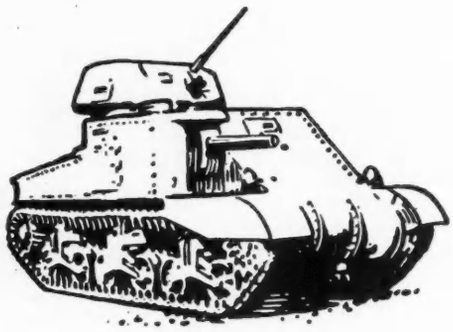
THE COLD METAL PRODUCTS CO.
Subsidiary of The Cold Metal Process Co., Youngstown, Ohio

What your defense dollars buy



The TANK is to the Army what the tackle is to the forward line of a football team. It is the "break-through." Head-on, it crashes timber, houses, enemy fortifications. Once it has opened the way, the attacking force follows for the "mopping up."

The Nazis, using these great steel pachyderms which they produce in vast quantities, have been able to break through every fortified line in 14 conquered countries.

In America, the medium-sized tank is the popular size. A medium-size tank weighs 30 tons. To make it takes as much steel as would be used in 500 refrigerators, as much rubber as goes into 87 average automobile tires.

The planning of a tank takes as great skill as a large-scale construction job. One recently converted automobile plant, faced with retooling for tank production, had to put 200 engineers to work in day and night shifts for one month, mapping out machinery requirements and plant layout.

To match the mechanical might of aggressor nations today, America needs thousands of these tanks. They're rolling off the assembly lines now. They cost real money. Every time you buy an $18.75 Defense Savings Bond or a 10¢ Defense Saving Stamp, you give your country money enough to buy a vital part for another new tank.

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AT ALL BANKS, POST OFFICES, AND SAVINGS AND LOAN ASSOCIATIONS

Two Four-Star Features

PRODUCTION METHODS are described in the first issue of each month;

AUTOMOTIVE MATERIALS are discussed in the second issue of each month

in

AUTOMOTIVE INDUSTRIES

The semi-monthly magazine of automotive industrial manufacturing establishments

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WIRE FORMS
SMALL STAMPINGS

Enter these doors and share in the results of B-G-R research and experience. You'll like the advisory service which has saved others grief, time and experimental expense in getting the proper spring. When you need wire forms or small stampings, have them made the B-G-R way, too. Two plants insure punctual shipments in large amounts or for emergency small lots. **Send inquiries to either plant.**

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BUYERS' GUIDE

Automotive Products and Factory Equipment Manufactured by Advertisers in This Issue

See Alphabetical List of Advertisers on page 86

This Buyers' Guide is published as a convenience, and not as part of the advertising contract. Every care will be taken to index correctly. No allowance will be made for errors or failure to insert.

Acid Sulphuric
New Jersey Zinc Co.

Alloys
Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Republic Steel Corp.

Ferro
Climax Molybdenum Co.
New Jersey Zinc Co.

Non-Ferrous
Aluminum Co. of America
Mallory & Co., Inc., P. R.
New Jersey Zinc Co.

Arms & Knuckles, Steering
Atlas Drop Forge Co.

Axles
Atlas Drop Forge Co.
Bethlehem Steel Co.
National Tube Co., U. S. Steel Corp. Subsidiary

Bearing Blue
Permatex Company, Inc.

Bearings

Brass, Bronze, Sleeve
Johnson Bronze Co.

Engine, Babbitt
Johnson Bronze Co.

Roller
Hyatt Bearings Division General Motors Corp.
Timken Roller Bearing Co. (tapered)

Blanks, Forged
Atlas Drop Forge Co.
Bethlehem Steel Co.
Wyman-Gordon Co.

Bolts
Bethlehem Steel Co.
National Acme Co.
Republic Steel Corp.

Brakes

Electrical
Wagner Electric Corp.

Camshafts
Atlas Drop Forge Co.
Bethlehem Steel Co.

Casings

Flexible (radio)
White Dental Mfg. Co.

Castings

Steel
Aluminum Co. of America
Aluminum Industries, Inc.
Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.

Cement

Cylinder Block, Fabric, Gasket, Glass, Pipe Joint, Radiator
Permatex Company, Inc.

Centers, Bench
Barber-Colman Co.
Morse Chain Co.

Channels for Glass, Felt
American Felt Co.

Chemicals

Degreasing
Curran Corp.

Chucks

Collet
National Acme Co.

Magnetic
Heald Machine Co.

Clamps, Hose (Adjustable)
Wittek Mfg. Co.

(*Turn to page 78, please*)

USE
PREVENT
CORROSION!
SMITH
Slushol
BRUSH IT!
SPRAY IT!
OR DIP IT!
EASY TO APPLY...EASY TO REMOVE
• FOR FOREIGN OR DOMESTIC SHIPMENTS •
Efficacy proved by years of use in leading Machine Tool and other plants.
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SMITH OIL & REFINING CO. • Industrial Oils Div. • 1108 Kilburn • ROCKFORD, ILL.

Cleaners
Air, Oil-Washed
United Specialties Co.
Engine, Chassis & Fender
Curran Corp.
Oakite Products, Inc.
Metal
Oakite Products, Inc.
Permatex Company, Inc. (Radiator)
Udylite Company

Clutches, Industrial
Borg & Beck Div., Borg-Warner Corp.
Twin Disc Clutch Co.

Compounds
Cutting Fluids
Oakite Products, Inc.
Buffing
Udylite Company
Gasket & Joint Sealing
Permatex Company, Inc.
Valve Grinding
Permatex Company, Inc.

Connecting Rods
Aluminum Co. of America
Atlas Drop Forge Co.
Bethehem Steel Co.
Wyman-Gordon Co.

Contact Points, Electrical
Mallory & Co., Inc., P. R.

Controls
Arens Controls, Inc.

Couplings
Pipe and Tubing
Dole Valve Co.

Crankshafts
Atlas Drop Forge Co.
Bethlehem Steel Co.
Wyman-Gordon Co.

Cutters, Gear
Keyseating, Milling
Barber-Colman Co.

BUYERS' GUIDE—(*Continued from page 77*)

Cylinder Heads, Aluminum
Aluminum Co. of America
Aluminum Industries, Inc.

Deflectors, Draft
Dole Valve Co.

Diamonds, Industrial
Smit & Co., Inc., Anton

Die Heads
National Acme Co.

Die Makers' Supplies
Danly Machine Specialties

Die Sections
Composite Steel
Jessop Steel Co.

Dies
Sets
Danly Machine Specialties

Discs, Clutch
Borg & Beck Div., Borg-Warner Corp.

Dovetails
Mitchell Div. United Specialties Co.

Drives
Power Unit
Cotta Transmission Corp.

Enamel
Engines Touch-up
Permatex Company, Inc.

Engines
Waukesha Motor Co.
Aircraft
Govro-Nelson Co.

Feeds, Roll for Punch Press
Littell Machine Co., F. J.
Wittek Mfg. Co.

Felt
American Felt Co.

Forgings
Aluminum Co. of America
Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Wyman-Gordon Co.
Drop
Atlas Drop Forge Co.
Wyman-Gordon Co.

Furnaces
Electric
Amer. Bridge Co., U. S. Steel Corp. Subsidiary
Electric, (Annealing, Carburizing, Heat Treating. Forging and Welding)
Electric Furnace Co.
Gas
Electric Furnace Co.
Oil
Electric Furnace Co.

Gages, Precision
Electrical (Fuel Level) Gasoline, Auto; Oil Pressure, Water Temperature
King-Seeley Corp.
Sheffield Gage Corp., The

Gaskets
Cork
Victor Mfg. & Gasket Co.
Felt
American Felt Co.
Victor Mfg. & Gasket Co.
Fibre
Victor Mfg. & Gasket Co.
Metallic Asbestos
Victor Mfg. & Gasket Co.

Gasoline
Ethyl Gasoline Corp.

Gear Boxes
Cotta Transmission Corp.

Gears
Reduction
Cotta Transmission Corp.

Grease Retainers
Victor Mfg. & Gasket Co.

Grinding Machines
Electric, Portable
Duro Metal Products Co.
Gear Cutting
Barber-Colman Co.
Hobbing
Barber-Colman Co.
Internal
Heald Machine Co.
Plain Tool
National Acme Co.
Surface
Heald Machine Co.
Valve Seat
Hall Mfg. Co.

Heat Treating
Barnes Co., Wallace, Div. of Associated Spring
Barnes - Gibson - Raymond, Div. of Associated Spring
Gibson Co., Wm. D., Div. of Associated Spring

Instruments, Electric
Roughness Rating
Physicists Research Co.

Lathes
Automatic
National Acme Co.
Chucking (Incl. Automat.)
National Acme Co.
Potter & Johnston Machine Co.
Semi-Automatic
National Acme Co.

Turret
National Acme Co.
Potter & Johnston Machine Co.

Wood Turning
Duro Metal Products Co.

Lubricators
Hand, Central System, Pressure
Lincoln Engineering Co.

Machines
Boring
Heald Machine Co.
Die Making
Wittek Mfg. Co.
Drilling
National Acme Co.
Filing
Wittek Mfg. Co.
Grinding
(See Grinding Machines)
Gear Cutting
Barber-Colman Co.
Hobbing
Barber-Colman Co.
Milling
(See Milling Machines)
Sawing
Wittek Mfg. Co.
Screw
National Acme Co.
Potter & Johnston Machine Co.
Shaft, Flexible
Duro Metal Products Co.
Straightening, for Punch Presses
Littell Machine Co., F. J.
Turret, Automatic
Potter & Johnston Machine Co.

Machine Work
Special Contract
Govro-Nelson Co.

Materials
Molding, Power
du Pont de Nemours & Co., Inc., E. I.
Plastic
(See Plastic Materials)
Welding, Rods
Mallory & Co., Inc., P. R. (Dies for Arc & Resistance Welding)

Metals
Spiegeleisen
New Jersey Zinc Co.
Thermosatic
Dole Valve Co.

Milling Machines
Kearney & Trecker Corp.
Potter & Johnston Machine Co.

Nuts
Bethlehem Steel Co.
National Acme Co.
Republic Steel Corp.
Speed
Tinnerman Products, Inc.

Oils
Fuel, Hardening & Tempering, Lubricating, Polishing, Rust Preventing, Slushing
Permatex Co., Inc.
Smith Oil & Refining Co.

Packing Sheets
Victor Mfg. & Gasket Co.

Pads, Felt
American Felt Co.

Paint, Aluminum
Aluminum Co. of America
Aluminum Industries, Inc.
Heat-Resisting
Permatex Co., Inc.

Pans Tote
All-Steel Equip Co.

Paper
Reinforced & Waterproof
Sisalkraft Co., The

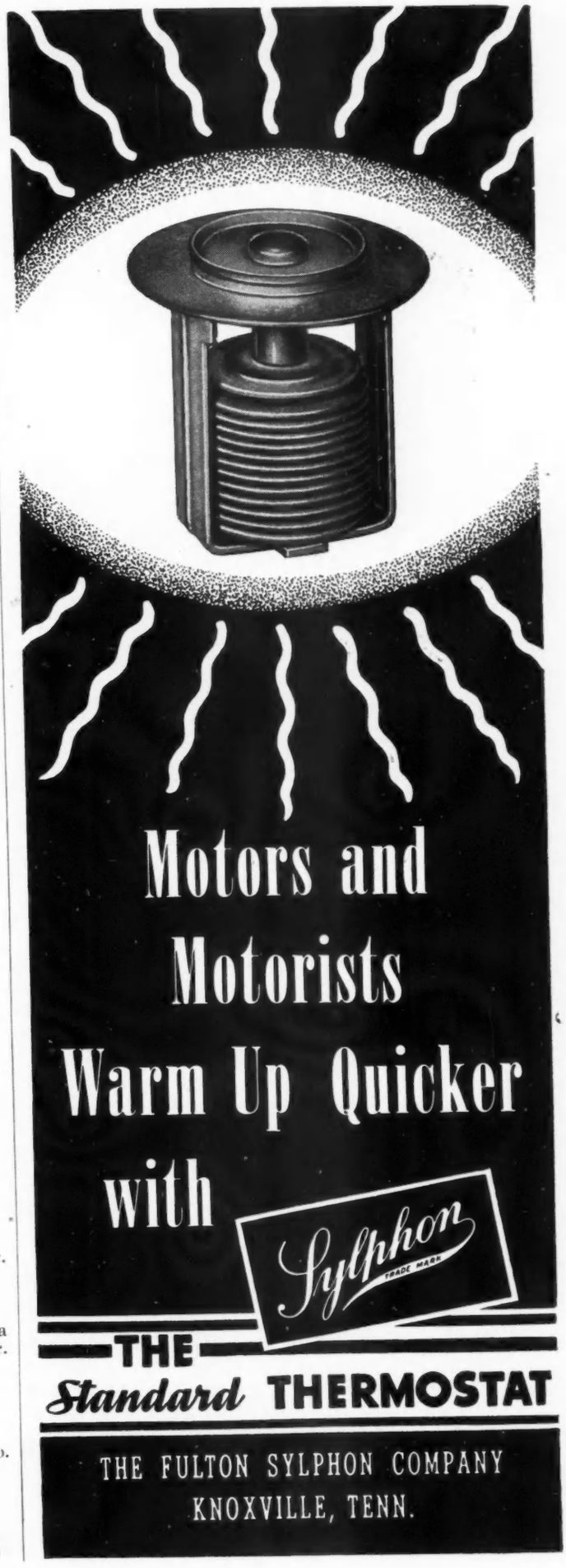
Parts
Aircraft Engine
Govro-Nelson Co.
Precision, Automotive
Govro-Nelson Co.

Pins, Piston
Aluminum Industries, Inc.

Pistons
Aluminum Co. of America
Aluminum Industries, Inc.

Plastic Material
Rods, Sheets, Tubes
du Pont de Nemours & Co.
Molded
Molded Products Co.

(*Turn to page 81, please*)



Keep Introducing Yourself to the *Newcomers*

There's no other way to do it, if you are going to be known by them, and remembered by your old contacts, when buying time comes.

Men you know are moving so rapidly from one position to another . . newcomers are entering organizations so generally . . it's just impossible to get around to all of them personally.

That's why we recommend that you commission AUTOMOTIVE INDUSTRIES to help you. It reaches these men twice every month, on their invitation. It's welcomed, and through your advertising message it can keep on re-introducing you to your old friends and to these newcomers.

AUTOMOTIVE INDUSTRIES

A CHILTON Publication

Chestnut and 56th Streets
Philadelphia, Pa.

BUYERS' GUIDE—(*Continued from page 79*)

Polish, Body
Automobile, Metal, Reflector-Chromium
Permatex Company, Inc.

Polishing Equipment
Udylite Company

Powerplants, Industrial (Portable)
Waukesha Motor Co.

Pre-Cleaner
United Specialties Co.

Presses
Drill
Duro Metal Products Co.
Forging, Hydraulic
Verson Allsteel Press Co.

Primers, Gasoline
Dole Valve Co.

Radio Remote Control
White Dental Mfg. Co.

Reamers
Inserted Tooth
Barber-Colman Co.

Reels, Automatic Centering (Coil Stock)
Littell Machine Co., F. J.

Removers, Enamel & Paint
Oakite Products, Inc.

Rings, Piston
Muskegon Piston Ring Co.

Rivets
Bethlehem Steel Co.
Progressive Mfg. Co.
Republic Steel Corp.

Rust Proofing
Oakite Products, Inc.

Saws
Band, Metal-Cutting
Duro Metal Products Co.

Screw Machine Products
Barnes Co., Wallace, Div. of Associated Spring
National Acme Co.
Progressive Mfg. Co.

Screw Stock, Cold Drawn
Union Drawn Steel Div. Republic Steel Corp.

Screws
Cap
National Acme Co.
Machine
National Acme Co.
Progressive Mfg. Co.
Set
National Acme Co.

Seals
Oil
Amer. Felt Co. (Gyro-Stat)
Permatex Company, Inc.
Victor Mfg. & Gasket Co.

Shafting
Bethlehem Steel Co.
Union Drawn Steel Div. Republic Steel Corp.
Hollow
National Tube Co., U. S. Steel Corp. Subsidiary
Steel, Cold Drawn
Jones & Laughlin Steel Corp.
Union Drawn Steel Div. Republic Steel Corp.
Turned, Ground & Polished
Jones & Laughlin Steel Corp.

Shafts
Axle
Mechanics Universal Joint Div. Borg-Warner Corp.
Flexible (Radio)
White Dental Mfg. Co.
Propeller & Transmission
Mechanics Universal Joint Div. Borg-Warner Corp.

Shims
Victor Mfg. & Gasket Co.

Springs
Extension, Compression, Torsion or Flat
Barnes Co., Wallace, Div. of Associated Spring Corp.
Barnes - Gibson - Raymond, Div. of Associated Spring Corp.
Cook Plant of Barnes-Gibson - Raymond Div. of Associated Spring Corp.

(*Turn to page 82, please*)

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Machining of aircraft and automotive engine parts to superfine precision clearances is the one thing in which we specialize and also excel—due in no small measure to the fact that the majority of our personnel of highly skilled men has been with Govro-Nelson continuously for a period of 10 to 15 years.

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THE GOVRO-NELSON COMPANY

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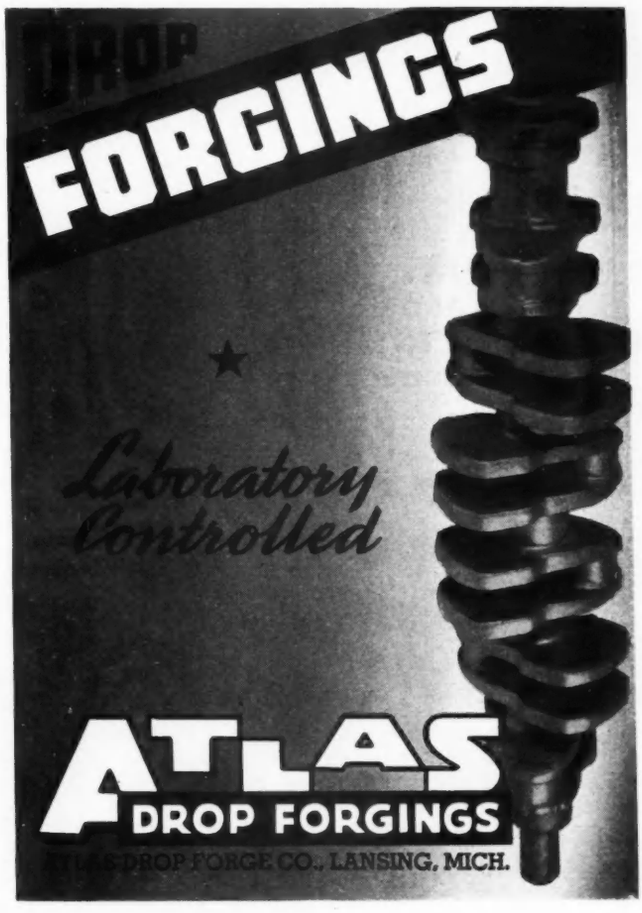

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MADE-TO-ORDER HEADED AND THREADED PARTS
We specialize in the design and manufacture of fastenings requiring special heads, threads, finishes or supplementary operations, in any metal or alloy adapted to the cold-upset process. Standard machine screws, stove bolts and nuts also supplied. Rivets and studs on special order only.
THE PROGRESSIVE MFG. CO.
Torrington . . Connecticut

BUYERS' GUIDE—(*Continued from page* 81)

Gibson Co., Wm. D., Div. of Associated Spring Corp.
Jones & Laughlin Steel Corp.
Raymond Mfg. Co., Div. of Associated Spring Corp.

Sprockets, Industrial Silent, Roller, Timing

Morse Chain Co.

Stampings or Drawings

Metal

Barnes Co., Wallace, Div. of Associated Spring
Barnes - Gibson - Raymond, Div. of Associated Spring
Cook Plant of Barnes-Gibson - Raymond Div. of Associated Spring Corp.
Gibson Co., Wm. D., Div. of Associated Spring
Niles Steel Products Div. Republic Steel Corp.
Raymond Mfg. Co., Div. of Associated Spring Corp.
Victor Mfg. & Gasket Co.
Worcester Stamped Metal Co.

Stands, Reel (Coil Stock)

Littell Machine Co., F. J.
Wittek Mfg. Co.

Steel

Alloys

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Jessop Steel Co.
Republic Steel Corp.
Union Drawn Steel Div. Republic Steel Corp.
Vanadium-Alloys Steel Co.

Bars

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Inland Steel Company
Jessop Steel Co.
Jones & Laughlin Steel Corp.
Republic Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. subsidiary

Billets

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Jones & Laughlin Steel Corp.
Republic Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary

Carbon

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Harrisburg Steel Corp.
Jessop Steel Co.
Jones & Laughlin Steel Corp.
Republic Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary

Cold Drawn (incl. Flats)

American Steel & Wire Co. U. S. Steel Corp. Subsidiary
Jones & Laughlin Steel Corp.
Union Drawn Steel Div. Republic Steel Corp.
Vanadium-Alloys Steel Co.

Electric Furnace

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Jessop Steel Co.
Union Drawn Steel Div. Republic Steel Corp.

Leaded

Inland Steel Company

Plates

Bethlehem Steel Co.
Inland Steel Company
Union Drawn Steel Div. Republic Steel Corp.

Rails

Bethlehem Steel Co.
Inland Steel Company

Shapes

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Jones & Laughlin Steel Corp.
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary

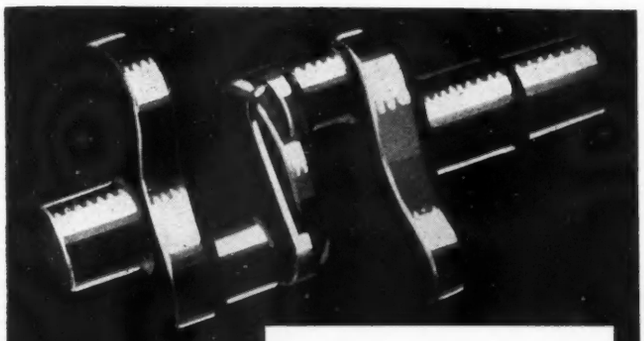
Sheets

Bethlehem Steel Co.
Carnegie - Illinois Steel Corp., U. S. Steel Corp.
Columbia Steel Co., U. S. Steel Corp. Subsidiary
Inland Steel Company
Tennessee Coal, Iron & Railroad Co., U. S. Steel Corp. Subsidiary
Union Drawn Steel Div. Republic Steel Corp.

Spring

American Steel & Wire Co., U. S. Steel Corp.
Barnes Co., Wallace, Div. of Associated Spring
Barnes - Gibson - Raymond, Div. of Associated Spring

(*Turn to page* 84, *please*)



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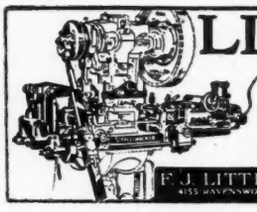

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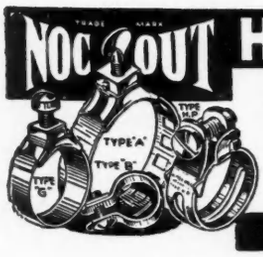

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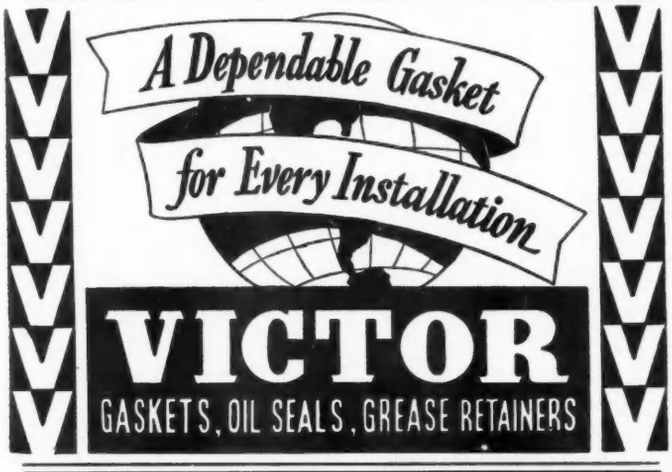

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A sensitive optical pyrometer takes temperature reading of Bethlehem sheet-strip in the continuous mill.

BETHLEHEM STEEL SHEETS

In the present emergency as in the past, Bethlehem Steel Sheets are giving a good account of themselves. That's only natural, for Bethlehem Sheets have been produced for years in a range of sizes, gages, treatments and finishes that is more than broad enough to handle practically every one of today's special tasks. In Army truck and scout car, in cartridge box and aerial-bomb fin assembly, Bethlehem Steel Sheets today are ready for any job our National Defense Program may offer.

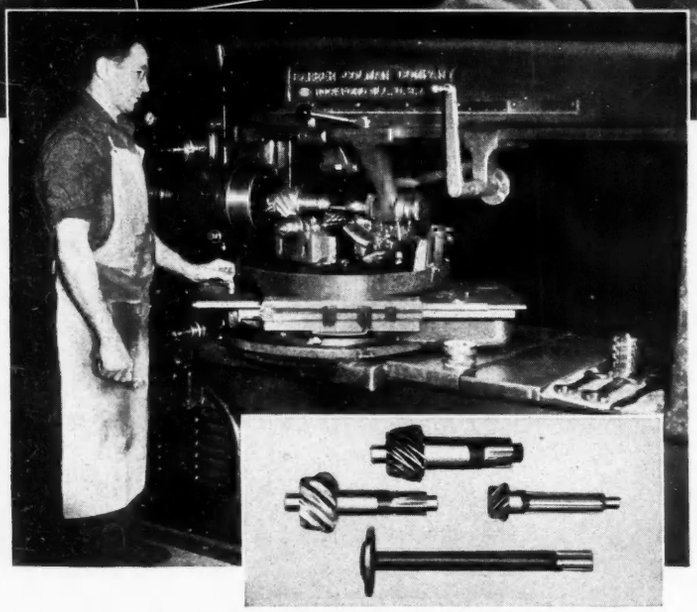
BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

Barber-Colman Gives You TAPER SPLINES

The Modern Way To Key Hubs On Shaft Ends

For Maximum Torque Capacity
Precision Mounting
Rapid Production
Simple Assembly



The above pinion drive shafts are hobbed on this Barber-Colman Type T Hobbing Machine in the shop of a large truck axle manufacturer. Note that this machine can also be used for hobbing Straight Splines, or for hobbing spur gears, helical gears and special hobbed forms, when desired.

● Write for Bulletin F-1403 which fully describes the B-C Type T Hobbing Machine, designed especially for producing Taper Splines in one operation on a production basis.

THE application of B-C Taper Splines to truck rear axle pinion drive shafts has greatly increased torque capacity and produced unfailing dependability.

Taper splines are quickly and economically hobbed on Type T Hobbing Machines, as shown. Here 6-key Taper Splines 2⅜" long by 2" O.D., are hobbed at the rate of 5 per hour, and one man can run four or more Hobbing Machines. Hob life is 100 pieces per sharpening.

Multiple integral keys provide super driving strength and the taper accurately locates the mating part concentric on the shaft. This method of mounting is unexcelled for heavy operation involving high torque or reciprocating stresses. Key-failure is eliminated and greater loads are transmitted. Mating hubs are readily produced by broaching a taper reamed hole with a standard spline broach.

B-C Taper Splines may improve the performance of your products or reduce maintenance cost. Why not ask Barber-Colman engineers for the complete facts on the application of Taper Splines to your products.

DATA ON THIS JOB

Part — Pinion drive shaft for truck axles; 4620 special steel, hobbed before hardening.

Operation — Hobbing Taper Spline 2⅜" long with 2.000" O.D., 1.620" to 2.000" tapered root dia., and 0.496" — 0.497" key width.

Hobbing Machine — Barber-Colman Type T Hobbing Machine.

Hob — Barber-Colman patented Taper Spline Hob; 3" dia. x 4" long with 1¼" straight bore; single thread; 16 gashes.

Work-Holding — Collet chuck between centers, located by means of a stop.

Feed — 0.028" per rev. of work... Hob Speed — 82 r.p.m.

Pieces per Sharpening — 100.

Production — 5 taper splines an hour.

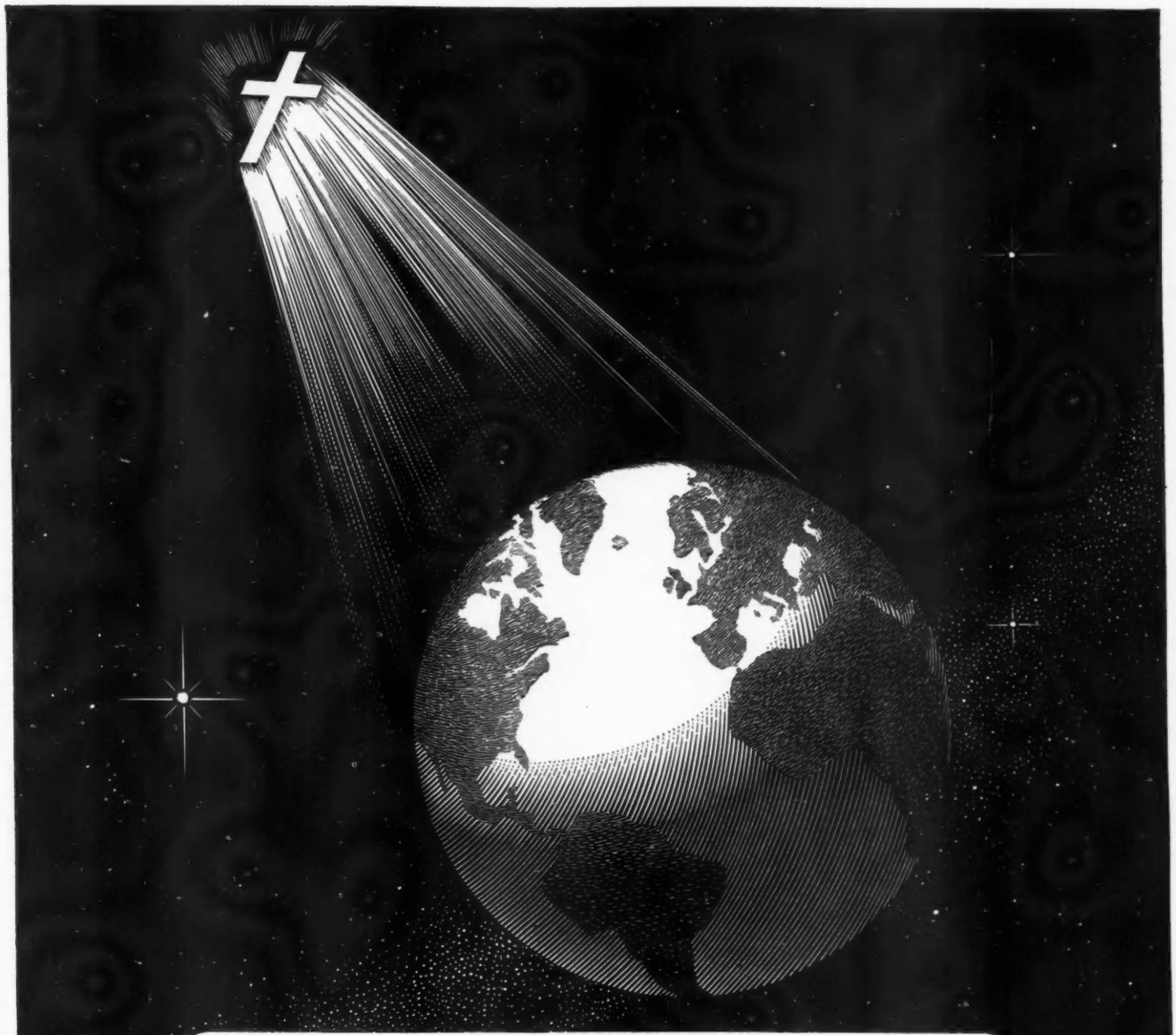
Remarks — In addition to taper splines, they use this Type T for cutting straight splines; some of which are on long shafts which extend through the machine spindle.

BARBER B-C COLMAN PRODUCTS

HOBS, HOBBING MACHINES, HOB SHARPENING MACHINES, REAMERS, REAMER SHARPENING MACHINES, MILLING CUTTERS, SPECIAL TOOLS

Barber-Colman Company

General Offices and Plant 205 Loomis St., Rockford, Illinois, U. S. A.



When the Might of this Light Shall Prevail

In this uncertain world, a few certain facts shall prevail to guide man's footsteps toward unending peace. The darkness will end; there shall be no more hate and fury; and the light of understanding will illuminate men's souls. The forces of civilization are joined in a pledge that will not falter in the accomplishment of victory

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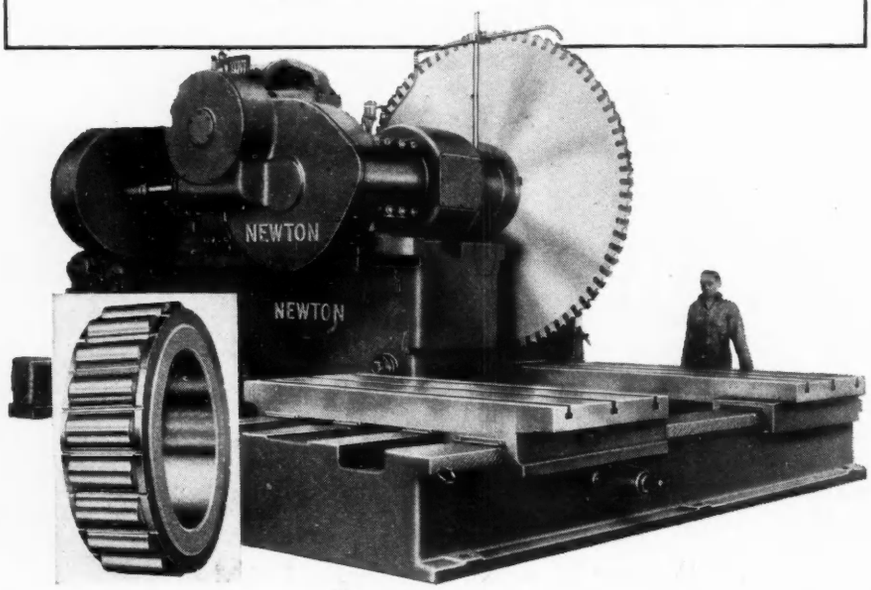
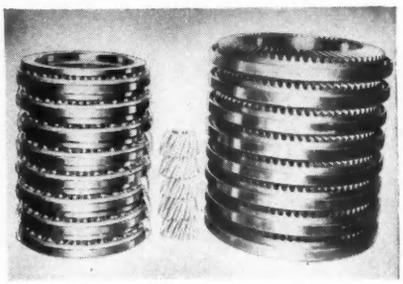
IN THE NEWS

WITH BANTAM BEARINGS

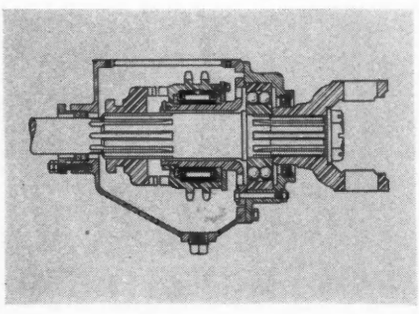


TEN-FOOT CIRCULAR BLADE is a striking feature of this Newton Cold Saw Cutting-off Machine manufactured by Consolidated Machine Tool Corporation—probably the largest machine of its type ever built. Bantam Radial Roller Bearings were selected by Consolidated for use in this giant machine because of their compactness and high load capacity. Here is a typical instance of Bantam's skill in meeting novel design requirements.



FOR HEAVY-DUTY WELL DRILLING, Pennington Signaling Core Barrel's 12¾" oil-bath rotary offers outstanding advantages in capacity and economy. Photo shows Bantam Ball Thrust Bearings and drive gears which give this rotary a capacity of 70 tons at 100 RPM, permit it to be operated continuously at 600 RPM when drilling. "Bantam Bearings are precision-made," says Mr. Harry Pennington, "and we could ask for nothing better than what you furnish. Our products are also precision-made to take advantage of Bantam's accuracy."

4000-TON FORMING PRESS built by Baldwin-Southwark is powered by two Oilgear Two-way Variable Displacement Pumps with a combined displacement of 143 gallons of oil per minute at pressures up to 3,000 pounds per square inch. Each pump rotor turns on large Bantam Radial Roller Bearings—7.0866" I.D. for front rotor bearings, 9.0551" I.D. for rear rotor bearings.



BANTAM SUPPLIES ANTI-FRICTION BEARINGS of many sizes and types to meet the requirements of Industry and Government for defense production. Because of Bantam's broad experience in the design and application of every major type of anti-friction bearing, Bantam engineers are exceptionally well qualified to undertake the solution of new and difficult bearing problems. For advice on anti-friction bearings, TURN TO BANTAM.

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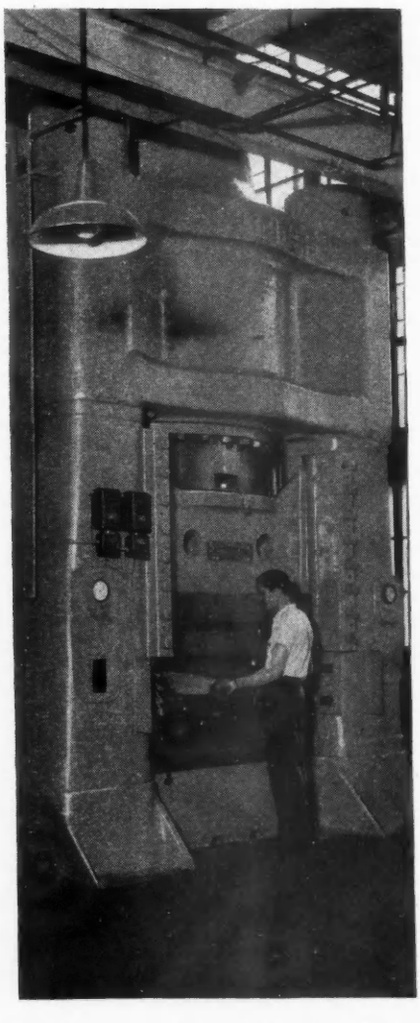

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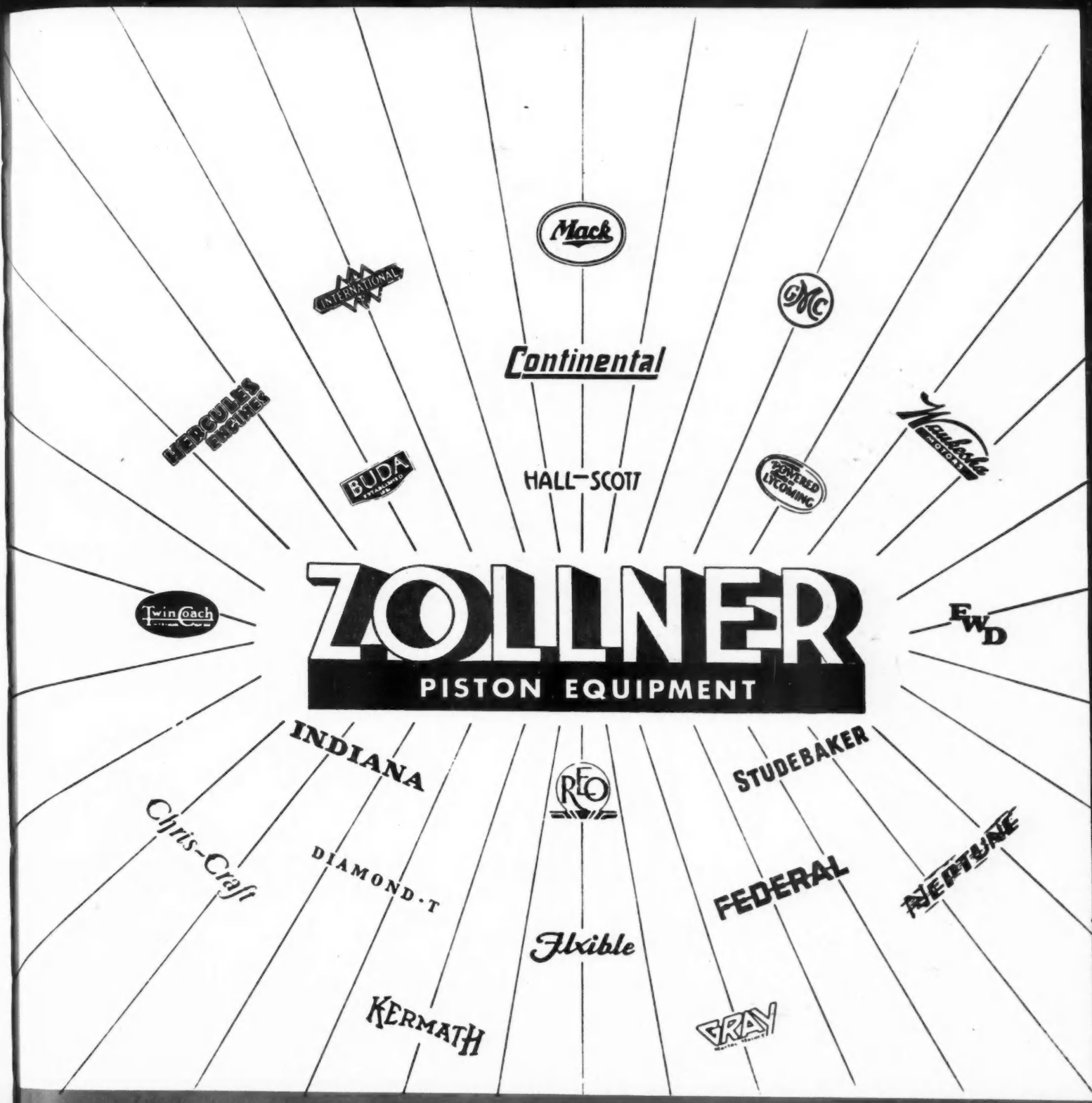

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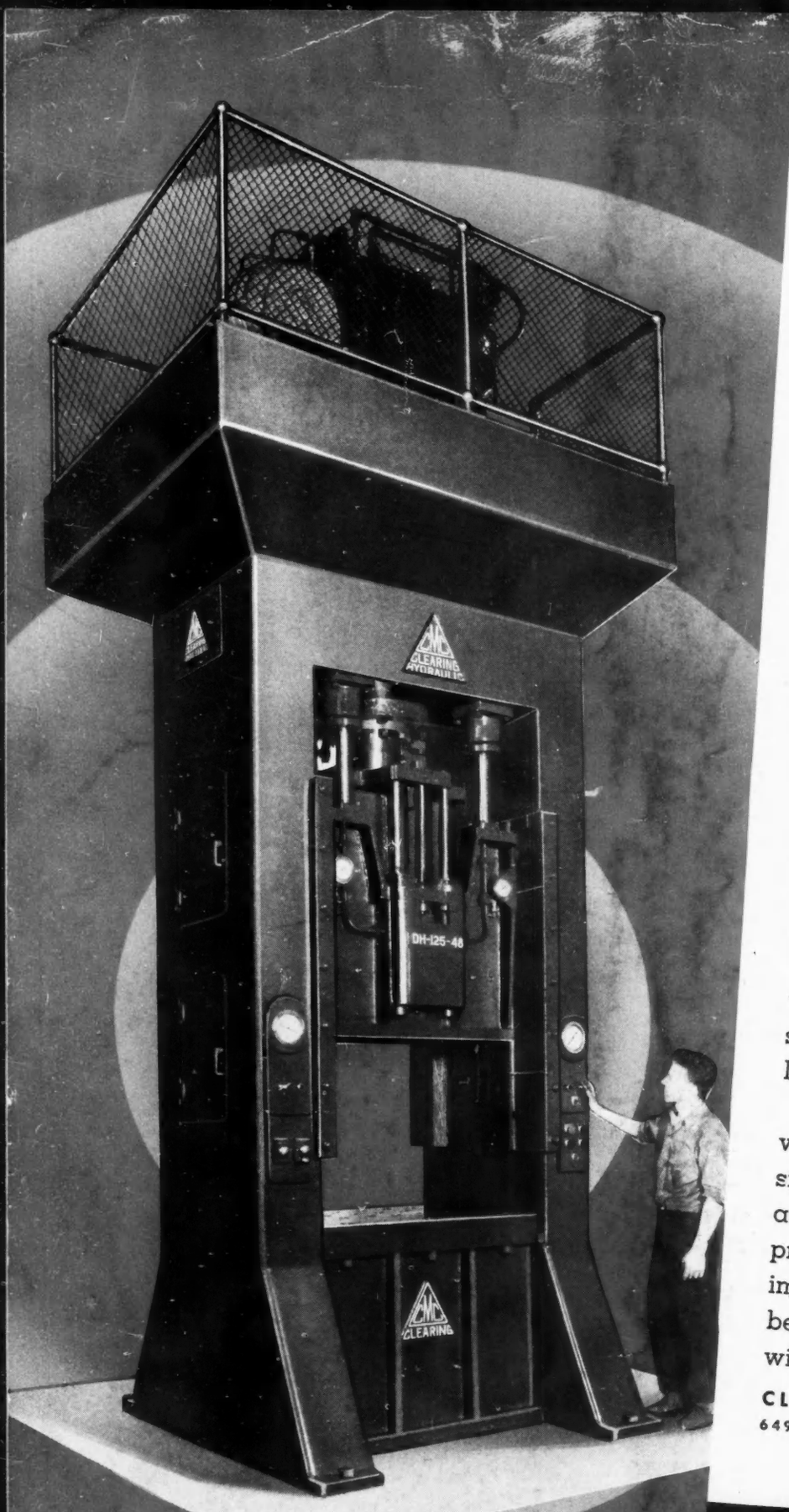

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